

# **Salmon, Steelhead, and Bull Trout Habitat Limiting Factors**

**For the Wenatchee Subbasin (Water Resource  
Inventory Area 45) and Portions of WRIA 40  
within Chelan County (Squilchuck, Stemilt and  
Colockum drainages)**

**FINAL REPORT**

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## ACKNOWLEDGMENTS

In accordance with RCW 77.85.070 (Salmon Recovery Act, previously Engrossed Senate House Bill 2496), a Technical Advisory Committee (TAC) was organized in March 2000 by the Conservation Commission in consultation with Chelan County, the Yakima Nation (YN), and the Colville Confederated Tribes (CCT), by inviting private, federal, state, tribal and local government personnel with appropriate expertise to participate.

The role of the TAC was to identify the limiting factors for anadromous salmonids and bull trout in the Wenatchee subbasin (WRIA 45) and the Squilchuck, Stemilt, and Colockum drainages of WRIA 40 (RCW 77.85.070[3]). The information was then incorporated into this report to support the Chelan County Lead Entity Committee in their effort to compile a habitat restoration/protection projects list, establish priorities for individual projects, and define the sequence for project implementation (RCW 77.85.050[1c]).

The TAC membership mailing list was extensive. It included the following persons, although actual participation in the TAC meetings and contribution to the development of the report through draft document reviews were represented by a core group, identified here with an asterisk:

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## AGENCY, ORGANIZATIONAL, AND OTHER ABBREVIATIONS

ACOE	Army Corps of Engineers
BLM	United States Bureau of Land Management
BPA	Bonneville Power Administration
CCCD	Chelan County Conservation District
CCT	Colville Confederated Tribes
CID	Chiwawa Irrigation District
CRITFC	Columbia River Inter-tribal Fish Commission
DNR	Washington Department of Natural Resources
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
GCFMP	Grand Coulee Fish Management Plan
LWD	Large Woody Debris
GIS	Geographic Information Systems
HPA	Hydraulic Project Approval
HUC	Hydrologic Unit Code
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service
NWPPC	Northwest Power Planning Council
NWIFC	Northwest Indian Fisheries Commission
PID	Peshastin Irrigation District
RTT	Regional Technical Team for the Upper Columbia Salmon Recovery Board
SASSI	Washington State Salmon and Steelhead Stock Inventory
SaSI	Washington Salmonid Stock Inventory
TAC	Technical Advisory Committee
UCSRB	Upper Columbia Salmon Recovery Board
USFS	United States Forest Service, Department of Agriculture
USFWS	United States Fish and Wildlife Service, Department of Interior
USGS	United States Geological Survey
WAC	Washington Administrative Code
WCC	Washington State Conservation Commission
WDOE	Washington Department of Ecology
WDF	Washington Department of Fisheries (superceded by WDFW)
WDW	Washington Department of Wildlife (superceded by WDFW)
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WSDA	Washington State Department of Agriculture
WDOT	Washington State Department of Transportation
YIN	Yakama Indian Nation (superceded by YN)
YN	Yakama Nation

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## EXECUTIVE SUMMARY

### General Information

This report addresses the portion of WRIA 45 that drains into the Wenatchee River and includes the Squilchuck, Stemilt, and Colockum watersheds of WRIA 40, all contained within the boundaries of Chelan County. The Wenatchee subbasin, Water Resource Inventory Area (WRIA) 45, drains a portion of the east slopes of the Cascade Mountains in north central Washington within Chelan County. Encompassing approximately 1,371 square miles, the subbasin is bounded on the west by the crest of the Cascade Mountains. It is bounded on the north and east by the Entiat Mountains and to the south by the Wenatchee Range. A tributary of the Columbia River, the Wenatchee River travels 54.2 miles before it empties into the Columbia River at the City of Wenatchee (RM 468.4), fifteen miles upstream of Rock Island Dam (RM 453.4), the seventh Columbia River dam upstream from the confluence of the Columbia River with the Pacific Ocean.

The Squilchuck, Stemilt and Colockum watersheds of WRIA 40 lie south of the City of Wenatchee where WRIA 40 extends northward into Chelan County. These watersheds drain directly into the Columbia River at RMs 464.0, 461.9 and 450.0, respectively. This portion of WRIA 40 is bounded on the west by Naneum and Mission ridges, on the south by Jumpoff Joe Ridge, and on the west to north by the Columbia River, Beehive Mountain and Dry Gulch.

Upper Columbia River summer steelhead, which includes the Wenatchee River run, were listed under the Endangered Species Act (ESA) as “endangered” on August 18, 1997. Upper Columbia River spring chinook salmon, which includes the Wenatchee River run, were listed under the ESA as “endangered” on March 24, 1999. Upper Columbia River bull trout, which includes the Wenatchee subbasin populations, were listed under the ESA as “threatened” on June 10, 1998. All stocks of steelhead and spring chinook in the Wenatchee subbasin identified by the state Salmon and Steelhead Stock Inventory report (SaSI; WDF/WDW 1993), are classified as “Depressed” based on chronically low production. The summer chinook salmon and the Wenatchee sockeye salmon, which both spawn and rear in the Wenatchee subbasin, are not ESA listed species and are classified as “Healthy” by the state SaSI based on escapement (WDF/WDW 1993). Coho salmon were extirpated from the Upper Columbia River region in the early 1900s. Efforts are presently underway by the Yakama Nation to reintroduce them.

In the late 1800’s, overfishing on the lower Columbia River severely depleted salmon runs to upper Columbia River tributaries (Chapman 1986). By the 1930s, anadromous salmonid runs in the Wenatchee subbasin were decimated because of overfishing in the lower Columbia River fisheries and irrigation diversion practices and habitat degradation in the subbasin. Bull trout populations in the Wenatchee subbasin may also have been negatively impacted by many factors, among them, habitat fragmentation resulting from dewatering and fish passage barriers created by turn of the century water diversions. In 1939, a hatchery program was launched to offset the loss of access and mitigate for

impacts created by the soon to be completed Grand Coulee Dam. Despite ongoing hatchery programs, resource managers have not been able to reestablish the spring salmon and steelhead populations of the Upper Columbia River region to self-sustaining levels. Failure can be attributed to a number of factors including passage problems and mortality associated with seven hydroelectric facilities on the mainstem Columbia River downstream of the Wenatchee River, unfavorable ocean conditions, harvest pressures, and degradation of ecological processes and habitat within the Wenatchee subbasin (Peven, 1992; WDF/WDW 1993; Williams et al. 1996).

This Salmon, Steelhead and Bull Trout Habitat Limiting Factors Report for the Wenatchee River subbasin focuses on habitat conditions in the subbasin as they affect the ability of the habitat to sustain naturally-producing salmonid populations. It provides a snapshot in time based on the data and published material available during the development of this report and the professional knowledge of the Technical Advisory Committee (TAC). Revisions to the report are not currently funded, however it is the hope of the Washington State Conservation Commission (WCC) that the information and assessment provided here will be utilized and built upon in future subbasin planning efforts designed to promote the restoration of self-sustaining salmonid populations in the Upper Columbia River Region.

Data in the literature on habitat conditions in the subbasin are well developed for federal USFS lands, which comprise about 76 % of the total subbasin. Data regarding habitat conditions on private lands is more limited and less readily available. However, a recent fish passage barrier inventory by Chelan County (Harza 2000), an in-progress Lower Wenatchee River Channel Migration Zone survey, and the initiation of Watershed Planning under RCW 90.82, also by Chelan County, will contribute to the knowledge base on private lands. Additionally, the creation of the Upper Columbia Salmon Recovery Board (UCSRB), has greatly contributed to a coordinated and more consistent consideration of habitat conditions and priorities within the Wenatchee subbasin. The UCSRB is a partnership among Chelan, Okanogan and Douglas counties, the Yakama Nation (YN) and Colville Confederated Tribes (CCT) in cooperation with local, state, and federal partners. The mission of the UCSRB is *to restore viable and sustainable populations of salmon, steelhead, and other at-risk species throughout the collaborative efforts, combined resources, and wise resource management of the Upper Columbia River Region*. Given the available information, during the development of this report, the TAC relied heavily upon its combined professional knowledge to assess the extent to which habitat conditions affect salmonid productivity in the Wenatchee subbasin. The TAC members' knowledge of habitat-forming processes and general salmonid habitat needs provided the basis for drawing conclusions in this report.

In the short-term, projects designed to treat symptoms of habitat degradation should be implemented with caution until a long-term salmonid habitat protection and restoration strategy can be developed. Focus should be removed from treating the effects of habitat degradation (ie. reduced pool quality and quantity, habitat, cobble embeddedness, reduced levels of LWD, high instream temperatures, and accelerated bank instability) with short-lived, engineered treatments (ie. stabilizing banks, anchoring woody debris,

planting vegetation and installing barbs) to diagnosis and treatment of the causes of habitat degradation. A long-term strategy should maintain a subbasin-wide, ecosystem-based approach and define a course of action to correct those factors that are causing the habitat degradation. Section 070 of the Salmon Recovery Act (RCW 77.85), directs the Lead Entity Citizen's Committee to develop this strategy. As per this legislation, Chelan County, Lead Entity for WRIA 45, have convened this Citizen's Committee. Components of the strategy for "prioritizing and implementing salmon restoration activities... in a logical sequential manner that produces habitat capable of sustaining healthy populations of salmon" are to include project monitoring, project evaluation, and adaptive management strategies. Integrated into the context of a long-term strategy, short-term structural channel manipulations can then be more biologically effective. All structural improvement projects should be designed so the placement is appropriate for the hydro-geomorphological characteristics of the reach.

### **Factors Affecting Natural Salmonid Production in the Wenatchee Subbasin.**

Anadromous salmonid populations in the Wenatchee subbasin are influenced by the following out-of-subbasin impacts; degraded estuarine habitat, fish harvest, unfavorable ocean conditions, and the affects of seven Columbia River reservoirs and hydroelectric dams on smolt and adult migration. Spring and summer chinook salmon, sockeye salmon, and steelhead trout must negotiate a 468 mile journey from the mouth of the Wenatchee River to the Pacific Ocean, once as smolts and again as adults. Out-of-subbasin impacts on anadromous salmonids are being addressed at the state and federal level in forums outside the salmonid habitat limiting factors assessment process presented here. The scope of this report will be limited to an assessment of subbasin habitat conditions only.

Within the subbasin, human alterations to the environment are exacerbating naturally limiting conditions by reducing habitat quality and quantity, thereby reducing a species' chances of successfully completing its life cycle. These alterations have primarily occurred in the lower gradient, lower reaches of watersheds in the lower subbasin and include road building and placement, conversion of riparian habitat to agriculture and residential development, water diversion, reduced large woody debris (LWD) recruitment, and flood control efforts that include LWD removal, berm construction, and stream channelization.

Maintaining the present level of habitat functionality and connectivity in watersheds of the upper Wenatchee subbasin is of primary importance for sustaining salmonid populations in the subbasin. This includes the Little Wenatchee/White River, Nason, and Chiwawa River watersheds where overall, habitat function is rated by the TAC as very high, with habitat concerns focused along transportation/utility corridors and on privately owned floodplains in lower reaches. Maintenance of functioning floodplain habitat may be achieved through many means, including but not limited to: conservation easements; out-right purchase from willing sellers; habitat protection ordinances; and any other means local citizens, scientists and policy makers can develop to achieve the maintenance of floodplain habitat functions. To maintain connectivity with the Nason Creek

watershed, there is also a strong need to restore floodplain function and riparian habitat in Nason Creek where state highway impacts, railroads, and utility corridors have confined the channel and reduced channel sinuosity in places.

To provide for the year-round spawning, rearing and migratory habitat needs of all life history stages of spring and summer chinook salmon, steelhead trout, sockeye salmon and bull trout, floodplain habitat along the Wenatchee River corridor must provide adequate quantities of naturally-forming, accessible, high quality, watered, off-channel habitat. Given that the level of functionality and connectivity of the upper watersheds is maintained, habitat conditions in the mainstem Wenatchee River (RM 0.0 – 54.2) have the greatest potential to affect salmonid fish production in the Wenatchee subbasin. The mainstem of the Wenatchee River serves as the corridor through which chinook, steelhead, sockeye and fluvial bull trout must pass to access habitat within the subbasin. It also maintains connectivity among the watersheds in the Wenatchee subbasin as well as with the greater Columbia River system.

Reestablishing passage at human-made fish passage barriers on Icicle Creek would provide access to a Wenatchee subbasin watershed that is mostly in a highly functional condition. This is dependent on fish passage through the boulder fields at RM 5.6 which may vary by species and with flow conditions. Reconnecting the Icicle watershed to the rest of the Wenatchee subbasin has the potential to contribute to: 1) maintaining bull trout populations and restoring the fluvial bull trout life history form to the Icicle Creek watershed; 2) reestablishing a strong, wild steelhead run in the Icicle Creek watershed; and 3) opening additional spawning and rearing habitat to spring chinook in the Wenatchee subbasin. To fully realize the potential benefits of reestablishing connectivity between the majority of the Icicle Creek watershed and the rest of the Wenatchee subbasin, low instream flows and high instream temperatures must also be addressed in Icicle Creek from the mouth upstream to RM 5.7. Habitat restoration projects aimed at restoring the channel's ability to dissipate energy and manage sediment loads would further improve salmonid productivity in the watershed. This includes restoring floodplain function and channel-forming processes within the lower 16.8 miles of Icicle Creek, and reducing human-induced sediment input.

The drainage/watersheds located in the lower portion of the Wenatchee subbasin (Chumstick drainage, Mission Creek watershed, and Peshastin Creek watershed) have been severely altered from their naturally functioning condition and are highly fragmented. Salmon, steelhead and bull trout populations in these drainages/watersheds are significantly reduced from their historic potential and, due to the existing land use activities and management issues, have less potential for recovery than watersheds in the upper Wenatchee subbasin. Among the Chumstick, Mission, and Peshastin watersheds, Peshastin Creek is of primary importance given the watershed's potential to contribute to bull trout, spring chinook, and steelhead production in the Wenatchee subbasin. The relative contribution to flows in the Wenatchee River from these drier watersheds of the subbasin is low, limiting the potential for these watersheds to contribute to improved flows in the mainstem Wenatchee River.

The Squilchuck, Stemilt and Colockum drainages of WRIA 40 are extremely low surface water producers given their arid climate and geologic condition. Fish production in these drainages are strongly affected by low water years when available moisture is limited to a brief spring runoff event with which to sustain instream flows in most reaches. In these drainages, only the lower reaches of Squilchuck, Stemilt and Colockum creeks have any potential to support anadromous salmonids, with the upper extent naturally limited by gradient and/or stream channel size and flows. These drainages are primarily or exclusively steelhead/rainbow trout waters with chinook use, when not precluded by flows, limited to “pull-in” rearing behavior by summer chinook and spring chinook juveniles migrating through the Columbia River system. However, of interest is the distribution and status of native redband trout populations in these watersheds, which may contribute to steelhead populations in high water years.

Little information exists regarding the impact of hydroelectric development in the Upper Columbia River system on bull trout, although recent radio telemetry data has documented adult bull trout living in the Columbia River are able to safely negotiate through the Rocky Reach and Wells Hydroelectric Projects (S. Bickford, Douglas County PUD, pers. comm., 2001). Earlier, Brown (1992) speculated that the conversion of the free-flowing upper Columbia River to a series of reservoir impoundments has had a negative effect on fluvial bull trout. However, maintaining self-sustaining populations of stream-resident, adfluvial and fluvial forms of bull trout within the Wenatchee subbasin is mostly dependent on providing properly functioning habitat and access to that habitat in sufficient quantities within the subbasin. Past fish harvest pressures within the subbasin, bolstered by relatively easy access, also have had a negative impact on bull trout populations in the subbasin.

Natural environmental conditions also can limit natural production of salmonids in the Wenatchee subbasin. In years when moisture availability is limited by climatic conditions, instream flows become severely reduced resulting in dewatered reaches, winter icing, and higher summertime water temperatures. Depending on the severity of the climatic conditions, the duration and extent of low instream flows and dewatered reaches can expand. These conditions restrict salmonid movements, dewater redds, and strand juveniles, resulting in direct mortality to salmonids. Catastrophic disturbances are also a natural component of this ecosystem and limit salmonid production. Landslides, floods and fire create a disturbance regime that cleanses, builds and replenishes the aquatic environment. While these events reduce habitat availability or function in one stream reach, they improve habitat conditions in another stream reach by recruiting spawning gravels and LWD while flushing sediment.

### **The Technical Advisory Group’s Recommendations Ranked in Order of Importance**

1. **Maintain highly functional habitat in Wenatchee subbasin watersheds.** The White/Little Wenatchee River and Chiwawa River watersheds represent systems that most closely resemble natural, fully functional aquatic ecosystems. In general these

watersheds support large, often continuous blocks of high-quality habitat and support all life-history stages of multiple salmonid species. Connectivity is good among subwatersheds and through the mainstem Wenatchee River corridor is good. The immediate strategy should be to maintain properly functioning habitat within these watersheds so they can continue to support robust salmonid populations resilient to normal environmental disturbances. These populations can then to expand their range into adjacent watersheds in the subbasin.

2. **Maintain and restore habitat on the mainstem Wenatchee River.** Recent research indicates that the mainstem Wenatchee River provides important habitat for many life stages of spring and summer chinook salmon and steelhead. The mainstem at this time is most vulnerable to riparian and instream habitat degradation. All remaining habitat functions on the mainstem Wenatchee River should be protected, and floodplain functions should be restored, especially in the Lower Wenatchee River (RM 0.0 – 25.6) and particularly from the Mission Creek confluence downstream to the Columbia River confluence (UCSRB RTT 2001). This includes riparian, and off-channel habitat located in the floodplain of tributaries to the Wenatchee River in this reach (i.e. berms in the vicinity of Cashmere and Monitor; oxbows cut off by railroads and state highways along Lower Nason Creek and Peshastin Creek). The in-progress Chelan County Lower Wenatchee River Channel Migration Zone study, once completed, should assist subbasin planning efforts to more confidently target and prioritize sites on the Lower Wenatchee River for protection and restoration. The study should also contribute to the development of a coordinated, subbasin-level approach to habitat maintenance and restoration that can address issues of maintaining habitat connectivity and habitat-forming processes.
3. **Restore ecosystem functions and connectivity within the Wenatchee subbasin.** The Nason Creek, Icicle Creek, and Peshastin Creek watersheds support important populations of salmon, steelhead or bull trout, maybe only at the subwatershed level, but have experienced a greater level of habitat alteration. Connectivity may still exist or could be restored within the watershed so it is possible to maintain or rehabilitate life history patterns and dispersal. Restoring ecosystem functions and connectivity within these watersheds should be priorities as per discussion within this report, especially in the Nason Creek watershed which supports the second strongest population of spawning spring chinook in the Wenatchee subbasin.
4. **Evaluate the relationship between stream flows and water use in the subbasin.** Low instream flows and dewatering in reaches naturally occur in areas of the Wenatchee subbasin. These conditions are related to climatic and geologic conditions. However, in areas of the subbasin where water diversions and withdrawals also occur, there is often a lack of clarity and confidence as to what the cause and affect relationship is between out-of stream water use, irrigation practices, naturally occurring conditions, and instream flow in a given stream reach. The extent to which improved water conservation practices and decreased water diversion and withdrawal may improve instream flows, appreciably improving salmonid production

in a given reach, requires further data collection and analysis. Specifically, a better understanding is needed of the potential effects of the Chiwawa Irrigation District water diversion on instream flows in the lower Chiwawa River. Alternatives to improve instream flows in the lower Wenatchee River, lower Icicle Creek, Peshastin Creek, and Mission Creek need to be investigated.

5. **Increase instream low-flows negatively impacted by human impacts.** Low instream flows from July until fall rains begin, are a natural condition in the subbasin and are highly variable from year to year based on climatic conditions. This condition can be exacerbated by human-induced changes in the subbasin, potentially altering the timing and magnitude of peak and base flows. During periods of low snowpack and drought, low flow conditions can extend earlier into the summer and later into the fall months. Natural low flow conditions can be exacerbated by the diversion and withdrawal of instream flows for irrigation and domestic use during July, August, and especially September. Given the natural variation in stream flows in the Wenatchee subbasin, developing and implementing water conservation practices and water use and delivery efficiencies for all water uses subbasin-wide is critical to insuring sustainability of naturally-producing, anadromous salmonids in the Wenatchee subbasin.

### **Summary of Habitat Conditions by Watershed**

Presented below is a summary, by watershed, of habitat conditions that have been identified by the TAC in the development of the report. A summary of habitat conditions in the Chumstick drainage (part of the Mainstem Wenatchee River Watershed) is also provided here. Its habitat issues are extensively identified in the literature and could not be adequately captured if lumped into the discussion of the mainstem Wenatchee River. A more detailed discussion of habitat conditions in each watershed can be found in the “Salmonid Habitat Conditions by Watershed” chapter of the report. Past and existing efforts to maintain and restore salmon habitat and other watershed management needs, are identified in the Northwest Power Planning Council (NWPPC) Wenatchee Subbasin Summary (2001).

**Mainstem Wenatchee River Watershed** (203,088 acres). Total juvenile salmonid densities in the Wenatchee River are primarily limited by the availability of high flow refuge habitat for post-emergent fry (Hillman and Chapman 1989a). Fry densities that exceed the river’s late summer rearing capacity may then be limited by available habitat quality and quantities during late summer (Hillman and Chapman 1989a). The mainstem Wenatchee River also provides overwintering habitat for juvenile spring chinook and juvenile steelhead. Since it is likely that juvenile steelhead emigrate from smaller tributaries into the mainstem Wenatchee River with the onset of colder stream temperatures, this emphasizes the importance of maintaining adequate winter rearing habitat in the mainstem Wenatchee River to accommodate an additional influx of rearing salmonids. Protecting and restoring habitat that provides both high and low flow refugia is critical to improving salmon and steelhead production in the Wenatchee subbasin. The most significant habitat impacts in this watershed include a loss of floodplain habitat and

habitat forming processes that develop and maintain habitat complexity. Water diversions and withdrawals that contribute to reduced flows during the late summer and early fall further exacerbate the problem of decreased habitat quantity and quality in the mainstem Wenatchee River during this period.

**Chumstick Creek Drainage** (47,000 acres). The Chumstick Creek drainage contributes approximately 0.2 % of the annual average flow to the Wenatchee River. Impacts to the channel migration zone from private land development, and sediment delivery from road densities on forest service lands, are the most important issues in this drainage and are driving habitat degradation. Many of the highly degraded habitat attributes affect channel morphology (road density and location, loss of floodplain connectivity, an alteration of disturbance regimes, loss of refugia, and loss of off-channel habitat). Additionally, instream flows are very low, upstream access is blocked at multiple locations, water quality is degraded, and high fine sediments may limit spawning success and food production (macroinvertebrate communities). The Chumstick drainage has been identified as one of the more problematic drainages in the entire Wenatchee subbasin relative to land use impacts and management issues.

**Mission Creek Watershed** (59,609 acres). The Mission Creek watershed contributes approximately 1 % of the annual average flow to the Wenatchee River. The largest factor contributing to the decline of spring chinook and steelhead in the watershed is dewatering, low flows, and the associated high instream temperatures in Mission Creek below Sand Creek, and in Brender Creek. Second in significance are the negative impacts to fish passage in the watershed. Fish passage barriers are created by dewatering and low flows near the mouth of Mission Creek and by culverts, dewatering/low flows, and diversion dams in the lower reaches of Brender, Yaksum, and E. Fk. Mission creeks, all major tributaries to Mission Creek. Finally, the loss of functioning habitat in the floodplain of Mission and Brender Creeks significantly reduces the production potential of the watershed. The lower reaches of these streams in their natural functioning condition, historically would have provided critical overwinter habitat for rearing juvenile salmonids in the Wenatchee subbasin, as well as a migration corridor, spawning habitat, spring high flow refugia for rearing juveniles and adult resting habitat. Channel alterations to accommodate roads, urban and residential development, and agriculture have resulted in a straightened channel without associated wetlands and riparian vegetation, that is disconnected from its floodplain and does not allow for habitat-forming processes. Along with responding to opportunities to reestablish floodplain functions, restoring upland habitat that has been impacted by harvest and road development will be necessary to restore channel functions in Mission Creek and its tributaries.

**Peshastin Creek Watershed** (78,780 acres). The Peshastin Creek watershed contributes approximately 4 % of the annual average flow to the Wenatchee River. The lost channel sinuosity, floodplain function, and riparian habitat (including off-channel habitat) within the channel migration zone of Peshastin Creek has had the greatest negative impact on salmonid production in the watershed and is driving habitat degradation. This impact is

caused primarily by the location of State Highway 97. Second to the impacts of lost channel function on Peshastin Creek are the impacts created by the Peshastin Irrigation District (PID) water diversion located at RM 4.8. As currently operated, the diversion negatively impacts salmon, steelhead and bull trout use in the watershed by contributing to low flow conditions that preclude adult bull trout migration, hinder spring chinook migration, and dewater the lower reach. Until the channel's ability to manage the transport and storage of water, bedload and LWD is restored to an appropriately functioning condition, and until human-induced, low flow conditions can be addressed, other salmonid habitat projects in the watershed will have a very limited or negligible affect on improving salmonid production. To improve the health and functionality of the Peshastin Creek ecosystem, habitat impacts in upper Peshastin Creek and in tributaries to Peshastin Creek must be addressed as well.

**Icicle Creek Watershed** (136,960 acres). The Icicle Creek watershed contributes 20 % of the annual average flow to the Wenatchee River. In the Icicle Creek watershed, natural conditions (steep gradients, water falls, flows) limit access in tributaries. However, given the total size of the watershed and the quality of the habitat, the remaining available portion of the watershed still offers a large amount of potentially productive habitat. This is dependent on fish passage through the boulder field at RM 5.6, which may vary by species and according to flow conditions. To make this upper watershed habitat accessible, habitat restoration in the lower Icicle watershed, that addresses human-induced impacts and is designed within a reach or other appropriate hydrologic unit, is necessary. The Icicle Creek watershed could then potentially contribute to: 1) maintaining bull trout populations and restoring the fluvial bull trout life history form in the Icicle Creek watershed (MacDonald et al. 2000); 2) reestablishing a strong, wild steelhead run in the Icicle Creek watershed; and 3) opening additional spawning and rearing habitat to spring chinook in the Wenatchee subbasin.

While protecting functioning floodplain and riparian habitat downstream of the wilderness boundary (RM 17.5; primarily habitat downstream of the Leavenworth National Fish Hatchery at RM 2.8), restoring full fish passage at human-made passage barriers on Icicle Creek is critical. Next, low flow conditions and associated high instream temperatures in the lower reaches of Icicle Creek from RM 5.7 at the Icicle/Peshastin Creek water diversion downstream to the mouth, negatively impact salmonid fish passage and decrease habitat quantity. Habitat degradation in the lower 3.8 miles of Icicle Creek needs to be addressed as well to fully realize the potential benefits of reestablishing connectivity between the majority of the Icicle Creek watershed and the rest of the Wenatchee subbasin. Habitat restoration projects that allow Icicle Creek to adjust to changes in flows and sediment within the channel migration zone of Icicle Creek would further improve salmonid productivity in the Icicle Creek watershed. This would include projects aimed at improving riparian habitat functions and floodplain functions.

**Chiwawa Creek Watershed** (117,000 acres). The Chiwawa River watershed contributes 15 % of the annual average flow to the Wenatchee River. Maintaining fish passage through the lower reach of the Chiwawa River is critical to sustaining spring

chinook, steelhead, and bull trout populations in the Wenatchee subbasin. Although impacts to the naturally functioning condition of the lower Chiwawa River have occurred, passage is not yet thought to be hindered. Protecting functioning floodplain and riparian habitat is the highest priority in this watershed, especially in the vicinity of the Chikamin Creek confluence. Investigating the extent to which the Chiwawa Irrigation Diversion (CID) contributes to elevated instream temperatures in the lower 3.5 miles of the Chiwawa River is second in priority. If water temperatures are or become substantially elevated in late summer in the lower Chiwawa river, the existing excellent connectivity of this watershed with important habitat throughout the Wenatchee subbasin could be weakened. Habitat in the watershed above Chikamin Creek (RM 13.8) is largely pristine. Brook trout should also be noted as one of the greatest threats to bull trout populations in the Chiwawa watershed. To date no brook trout have been observed in the upper watershed, but brook trout are well established in the lower watershed (especially in Chikamin Creek) and no barriers hinder brook trout access to the upper watershed.

**Nason Creek Watershed** (69,000 acres). The Nason Creek watershed contributes 18 % of the annual average flow to the Wenatchee River. The significance of the Nason Creek Watershed lies in its potential contribution to spring chinook production in the Wenatchee subbasin and its connectivity to the upper Wenatchee subbasin salmonid populations, especially the bull trout subpopulation. Maintaining the remaining functioning floodplain and riparian habitat is the first priority in the Nason Creek watershed. Habitat restoration projects that allow Nason Creek to adjust to changes in flows and sediment within the channel migration zone is second in priority. This would include projects aimed at improving riparian habitat functions and floodplain functions, especially reconnecting off-channel habitat to the extent it is determined to cumulatively show an appreciable improvement in channel function. Habitat restoration projects aimed at reducing sediment delivery to stream channels from human-induced causes should be the third in priority. The location of highways, railroad and powerline corridors adjacent to Nason Creek have confined and straightened the channel in places. Timber harvest, road development and conversion of the floodplain to residential uses in Nason Creek and its tributaries from RM 15.4 downstream have degraded and reduced spawning and rearing habitat in the watershed.

**White/Little Wenatchee River Watershed** (175,285 acres). The White and Little Wenatchee River combined contribute 40% of the annual average flow to the Wenatchee River (25% and 15%, respectively). Maintenance of functioning floodplain and riparian habitat, including shallow water habitats and shoreline habitat of Lake Wenatchee, is the highest priority in this watershed. Loss of floodplain function on the White and the Little Wenatchee Rivers is the greatest threat to salmonid production in the White/Little Wenatchee Watershed. The White and the Little Wenatchee Rivers have among the best aquatic habitat and strongest native fish populations anywhere in the Columbia basin (USFS 1998m). The connectivity between these two watersheds and other good aquatic habitat is also among the best in the Columbia basin. Their connectivity to a large, undammed lake, Lake Wenatchee, also adds to their high regional value (USFS 1998m). Much of the reason for the high aquatic health of these watersheds is that in the depositional reaches near the mouth of both rivers, both the structurally complex,

meandering channels and the broad, wetland-filled floodplains remain largely undeveloped, despite the presence of considerable private land.

Reducing the effects of road density and location in the Little Wenatchee River drainage is second in priority in the watershed, with emphasis on Rainy Creek and the Little Wenatchee River from the mouth upstream to Cady Creek (RM 16.9), followed by restoring wetland connectivity and function in the vicinity of the Lake Wenatchee inlet. Additionally, timber harvest within riparian areas on the mainstem Little Wenatchee and Rainy Creek has further reduced potential LWD recruitment, altered runoff and water storage patterns, and increased fine sediment input into receiving waters. Restoring wetland connectivity and function is second to habitat protection in the White River drainage.

**WRIA 40 Squilchuck, Stemilt and Colockum Watersheds** (96,882 acres). The extent to which these watershed can support salmon and steelhead/rainbow trout is most strongly limited by the natural hydrology and geology in these low precipitation watersheds. Because of the reliance on snow accumulation and snowmelt to support instream flows and the high permeability of the soils, perennial flows are not supported in many areas limiting access to habitat. This condition is worsened during low water years. Given the natural geology of the watershed, chinook salmonid use is naturally limited to the lowest reach of the tributaries to the Columbia River, before steep channel gradient precludes upstream fish passage. Adult steelhead trout could naturally penetrate higher into the watershed on good water years, given passage at culverts and diversion dams. However, intermittent flows later in the year, coupled with severe habitat degradation present significant limitations to steelhead/rainbow productivity in these watersheds. The status and distribution of the native redband trout populations is unknown for these watersheds.

### **Wenatchee Subbasin Inventory and Assessment Data Gaps**

Following are the overriding subbasin-level inventory and assessment data gaps for the Wenatchee subbasin. Obtaining this information will increase the ability of the public and technical staff to make natural resource management decisions at the subbasin-level with a higher degree of confidence in the outcomes. Data gaps at the watershed level are listed in the “Salmonid Habitat Conditions by Watershed” chapter of the report.

- A study is needed to define current floodplains and riparian habitat in the Wenatchee River corridor in terms of channel form and process. This would contribute to the development of a habitat protection and restoration strategy that would address issues of maintaining habitat connectivity and habitat-forming processes. Chelan County has initiated a Channel Migration Zone Study of the Wenatchee River from the bottom of Tumwater Canyon downstream to the Columbia River confluence, including the lower 4.0 miles of Nason Creek. Supplemental studies may be needed.
- A hydrologic assessment is needed to evaluate groundwater and surface water interactions (including the effect of water diversions and withdrawals on ground and

surface water), identify critical ground water recharge areas, and identify locations where groundwater contributes to surface water in the Wenatchee River corridor, including the alluvial fans. A measure of the affect this interaction has on moderating high summertime stream temperatures and low summer/fall instream flows should be included. These factors should be addressed by the Watershed Planning Unit in Phase II of Wenatchee Watershed Planning (RCW 90.82).

- More information is needed on bull trout distribution and habitat use for all life history forms found in the Wenatchee subbasin (fluvial, adfluvial, and resident). The extent of habitat fragmentation (i.e. water crossing structures, thermal barriers, dewatering/low flows) on bull trout, both its causes and affects, is needed.

# INTRODUCTION

## Habitat Limiting Factors Background

The successful recovery of naturally spawning salmon populations depends upon directing actions simultaneously at harvest, hatcheries, habitat and hydroelectric facilities, the “4H’s”. The 1998 state legislative session produced a number of bills aimed at salmon recovery. This report was written pursuant to Engrossed Substitute House Bill (ESHB) 2496 as codified in RCW 77.85, the Salmon Recovery Act, a key piece of the 1998 Legislature’s salmon recovery effort. It represents a compilation of information regarding known habitat conditions in the Wenatchee subbasin, Water Resource Inventory Area (WRIA) 45, and in the Squilchuck, Stemilt, and Colockum watersheds in WRIA 40, all of which fall within the boundaries of Chelan County.

RCW 77.85 in part:

- directs the Conservation Commission in consultation with local government and the tribes to invite private, federal, state, tribal and local government personnel with appropriate expertise to act as a technical advisory group (section 070, subsection 1, RCW 77.85);
- directs the technical advisory group to identify limiting factors for salmonids to respond to the limiting factors relating to habitat pursuant to section 060 subsection 2(a) of this RCW (section 070, subsection 3, RCW 77.85);
- defines limiting factors as “conditions that limit the ability of habitat to fully sustain populations of salmon.” (section 010, subsection 5, RCW 77.85);
- defines salmon as “all members of the family Salmonidae which are capable of self-sustaining, natural production.” (section 010, subsection 7, RCW 77.85).

The overall goal of the Conservation Commission’s limiting factors project is to identify habitat factors limiting production of salmonids in the State. At this time, the report identifies habitat limiting factors pertaining to salmon, steelhead trout and bull trout. It is important to note that the responsibilities given to the Conservation Commission in ESHB 2496 do not constitute a full limiting factors analysis. The hatchery, hydro and harvest segments of identifying limiting factors are being dealt with in other forums.

This limiting factors report includes the portion of WRIA 45 that drains into the Wenatchee River and the Squilchuck, Stemilt, and Colockum watersheds of WRIA 40, all contained within the boundaries of Chelan County (Figure 1: Map of Watershed (HUC 5) in WRIA 45 and Portions of WRIA 40).

Figure 1: Map of Watersheds (HUC 5) in WRIA 45 and Northern Portion of WRIA 40



Not included in this report is the portion of WRIA 45 located on the west side of the Columbia River and extending from the south part of the City of Wenatchee at Dry Coulee northward to Rocky Reach Dam. This area contains tributaries that drain directly into the Columbia River but are seasonal in nature and do not support salmonid populations. The watersheds of WRIA 45 are; Mainstem Wenatchee River, Mission Creek, Peshastin Creek, Icicle Creek, Chiwawa River, Nason Creek, and the White/Little Wenatchee River. The watershed boundaries are consistent with the USFS Hydrologic Unit Code (HUC) 5<sup>th</sup> field boundaries in place in 2001. For reference, Table 1 provides river miles for various tributaries in WRIA 45 and WRIA 40, the Upper Columbia region, and Columbia River hydroelectric dams. River miles provided in the Washington Stream Catalogue (Williams et al. 1975) were used where available. When not available, river miles were derived from routed GIS coverages and /or global positioning system (GPS) coordinates and are therefore also approximate.

**Table 1: River Miles for Landmarks**

<b>Landmark</b>	<b>Columbia River Mile (*RM)</b>	<b>Wenatchee River Mile (*RM)</b>	<b>Tributary River Mile (*RM)</b>
Bonneville Dam	146.1		
Dalles Dam	191.5		
John Day Dam	215.6		
McNary Dam	292.0		
Priest Rapids Dam	397.0		
Wanapum Dam	415.8		
Rock Island Dam	453.4		
Colockum Creek	450.0		
Stemilt Creek	461.9		
Squilchuck Creek	464.0		
Squilchuck State Park			6.0
Miners Creek			6.3
Dry Gulch	464.6		
Wenatchee River/City of Wenatchee	468.4		
Sleepy Hollow Bridge		3.5	
Town of Monitor		6.0	
Town of Cashmere		10.4	
Mission Creek		10.4	
Brender Creek			0.2
Yaksum Creek			1.9
Sand Creek			7.5
E. Fk. Mission Creek			10.2
Devil's Gulch			10.3
Dryden Dam		17.0	

**Table 1: River Miles for Landmarks**

<b>Landmark</b>	<b>Columbia River Mile (*RM)</b>	<b>Wenatchee River Mile (*RM)</b>	<b>Tributary River Mile (*RM)</b>
Peshastin Creek		17.9	
Peshastin Irrigation District diversion dam			2.4
Peshastin Irrigation District water diversion			4.8
Mill Creek			5.2
Camas Creek			6.2
Pioneer-Gunn diversion			6.6
Jones-Shotwell diversion			7.2
Hansel Creek			8.7
Ingalls Creek			9.4
Natural falls			9.8
Ruby Creek			10.5
Negro Creek			11.1
Natural falls			2.9
Magnet Creek			14.8
Tronsen Creek			14.9
Shaser Creek			15.5
Scotty Creek			16.6
Derby Creek		19.0	
Town of Peshastin		19.5	
Chumstick Creek		23.5	
North Road crossing			0.3
Eagle Creek			1.9
Leavenworth bridge		23.9	
Town of Leavenworth		25.0	
Icicle Creek		25.6	
Leavenworth National Fish Hatchery (LNFH) return flow			2.6
LNFH spillway (on canal)			2.8
LNFH Dam 5 (historic channel)			3.0
LNFH headgate dam (Dam 2 on historic channel)			3.8
LNFH/Cascade Orchards Irrigation District Co. diversion dam and intake			4.5
Snow Creek			5.4
Icicle Creek boulder field			5.6
Icicle/Peshastin Irrigation District diversion dam			5.7
Rat Creek			7.9
Eightmile Creek			9.0
Chatter Creek			16.7

**Table 1: River Miles for Landmarks**

<b>Landmark</b>	<b>Columbia River Mile (*RM)</b>	<b>Wenatchee River Mile (*RM)</b>	<b>Tributary River Mile (*RM)</b>
Trout Creek			16.8
Jack Creek			17.2
Natural falls			24.0
French Creek			21.6
Tumwater Dam		31.0	
Top of Tumwater Canyon		35.6	
Chiwaukum Creek		36.0	
Skinney Creek			0.6
Natural falls			4.3
Town of Plain		46.2	
Beaver Creek		46.5	
Chiwawa River		48.4	
Chiwawa Irrigation District (CID) diversion			3.6
Deep Creek			4.0
Chelan PUD fish weir			8.0
Big Meadows Creek			9.2
Chikamin Creek			13.7
Rock Creek			21.3
Phelps Creek			30.7
Natural falls			0.64
James Creek			31.2
Alpine Creek			31.7
Buck Creek			33.0
Natural falls			0.4
Chiwawa River natural falls			33.1
Parkside Store		53.0	
Nason Creek		53.6	
Kahler Creek			5.1
Roaring Creek			8.4
Natural falls			1.1
Gill Creek			9.3
Whitepine Creek			14.6
Natural falls			3.4
Gaynor Falls			16.8
Henry Creek			18.7
Steep, impassable gradient			0.25
Mill Creek			19.9
Natural falls			0.6
Bygone Byways			20.5

**Table 1: River Miles for Landmarks**

<b>Landmark</b>	<b>Columbia River Mile (*RM)</b>	<b>Wenatchee River Mile (*RM)</b>	<b>Tributary River Mile (*RM)</b>
Lake Wenatchee		54.2	
White River		58.6	
Sears Creek			7.7
Canyon Creek			10.0
Napeequa River			11.0
natural falls			2.2
Panther Creek			13.1
natural falls			0.7
White River Falls			14.3
Little Wenatchee River		58.6	
Little Wenatchee Falls			7.8
Rainy Creek			8.4
natural falls			5.5
Rocky Reach Dam	473.7		
Entiat River	483.6		
Wells Dam	515.6		
Methow River	523.9		
Okanogan River	533.1		
Chief Joseph Dam	545.1		
Grand Coulee Dam	596.6		

\* River miles are all approximate. River miles provided in the Washington Stream Catalogue (Williams et al. 1975) were used where available. When not available, river miles were derived from routed GIS coverages and /or global positioning system (GPS) coordinates and are therefore also approximate.

**The Role of Habitat in a Healthy Population of Natural Spawning Salmon**

Washington State anadromous salmonid populations have evolved in their specific habitats during the last 10,000 years (Miller 1965). Water chemistry, flow, and the physical attributes unique to each stream have helped shape the characteristics of each salmonid population. These unique physical attributes resulted in a wide variety of distinct salmonid stocks for each salmonid species throughout the State. Stocks are population units within a species that do not extensively interbreed because returning adults rely on a stream's unique chemical and physical characteristics to guide them to their natal grounds to spawn. This maintains the separation of stocks during reproduction, thus preserving the distinctiveness of each stock.

Salmonid habitat includes physical, chemical and biological components. Within freshwater and estuarine environments, these components include water quality, water

quantity or flows, nutrients, stream and river physical features, riparian zones, upland terrestrial conditions, and ecosystem interactions as they pertain to habitat. These components closely intertwine. For example, changes in stream flows can alter water quality by affecting temperatures, decreasing the amount of available dissolved oxygen, and concentrating toxic materials. Water quality can be reduced by heavy sediment loads which result in increased channel instability and decreased spawner success. The riparian zone interacts with the stream environment, providing nutrients and a food web base, woody debris for habitat and flow control (channel complexity), filtering runoff prior to surface water entry (water quality), and providing shade to aid in water temperature control.

Salmonids require clean, cool, well-oxygenated water flowing at a natural rate for all stages of freshwater life. Salmonid survival depends upon specific habitat needs for egg incubation, juvenile rearing, migration of juveniles to saltwater, estuary rearing, ocean rearing, adult migration to spawning areas, and spawning. Specific needs vary by species and even by stock.

When adults return to spawn, they not only need adequate flows and water quality, but also unimpeded passage to natal grounds. They need pools with vegetative cover and instream structures such as root wads to provide for resting and shelter from predators. Successful spawning and incubation requires sufficient gravel of the right size for the stock (or population), in addition to the constant need of adequate flows and water quality, all in unison at the necessary location. Also, delayed upstream migration can be critical to spawning success. After entering freshwater, salmon have a limited time to migrate and spawn, sometimes as little as 2-3 weeks. Delays result in pre-spawn mortalities, or spawning in sub-optimal locations.

After spawning, the eggs need stable gravel that is not choked with fine sediment. River channel stability is vital at this life history stage. Floods have their greatest impact to salmon populations during incubation, and human activities can exacerbate these impacts. In an undisturbed system, upland vegetation stores water and shades snowpack slowing the rate of water runoff into the stream. A healthy river system has tributaries or stream reaches with sinuosity and large pieces of wood contributed by an intact, mature riparian zone. The uplands and riparian areas both act to slow the speed of water downstream. Natural river systems also have access to floodplains where wetlands store flood water and later discharge this storage back to the river during lower flows. Erosion or sediment produced in a healthy system provides a constant supply of new gravel for spawning and incubation without increasing overall channel instability. A stable incubation environment is essential for salmon. It is a complex function of nearly all habitat components contained within that river ecosystem.

When the young fry emerge from the gravels, summer chinook migrate downstream, quickly exiting the subbasin, while other species of salmonids like spring chinook, steelhead and bull trout, search for suitable rearing habitat within side channels and sloughs, tributaries, spring-fed "seep" areas, and stream margins within the subbasin. Quiet water margins and off channel areas are vital for early juvenile habitat. The presence of woody debris and overhead cover aid in food and nutrient inputs as well as

provide protection from predators. Juveniles use this type of habitat in the spring. Most sockeye populations migrate from their nests quickly to larger lake environments where they have unique habitat requirements. These include water quality sufficient to produce the necessary complex food web to support one to three years of salmon growth in the lake habitat prior to outmigration to the estuary.

As growth continues, the juvenile salmonids (parr) will move away from the quiet shallow areas into deeper, faster water. This movement is coincident with the onset of summer low flows, which constrain salmon production by reducing the total quantity of available habitat. Streamflow, one of the basic determinants of the amount of space available for fish, varies seasonally in ways that depend on geography and climate (Bjornn and Reiser 1991) with low flows sometimes extending into the fall and winter seasons in some Wenatchee subbasin tributaries and stream reaches. Space suitable for occupancy by salmonids in streams is a function of streamflow, channel morphology, gradient, and (in many instances) various forms of instream or riparian cover. Suitable space for each salmonid life stage has water of sufficient depth and quality flowing at appropriate velocities. The addition of cover (extra depth, preferred substrates, woody debris, etc.) increases the complexity of the space and usually the carrying capacity. (Bjornn and Reiser 1991).

With the exception of summer chinook, salmonid juveniles that rear in the subbasins of the upper Columbia River (spring chinook, steelhead/rainbow, sockeye and bull trout) spend at least one winter in their respective subbasins before emigrating out of the tributaries and into the Columbia River. Adult steelhead which may overwinter in the upper-Columbia region as well. These overwintering salmonids require habitat that will sustain growth and protect them from predators and harsh winter conditions. Habitat use is determined by behavior changes associated with declining temperatures in the fall and winter. Behavior changes vary by species and life stage (Bjornn and Reiser 1991). For example, in a study of seasonal habitat use of juvenile chinook salmon and steelhead in the Wenatchee River (Don Chapman Consultants 1989), juveniles were located along the stream margin in boulder zones during the winter (from October to March). During the day they hid in interstitial spaces among boulders; at night both species stationed on boulders and sand adjacent to their daytime habitat. When water temperatures dropped below 50 °F (10 °C), juveniles were not observed in the water column during the daytime, but remained in the substrate. In another example, bull trout embryos and alevins remain in the gravels for more than 200 days over winter (Fraley and Shepard 1989) making their survival closely dependant on relatively stable thermal regimes and substrate conditions. In a study of bull trout in the Flathead Valley of Montana, Baxter et al. (1999) considered that groundwater-influenced areas within alluvial valley areas in Montana may be important to egg incubation, emergence success, and the survival of juvenile bull trout, to the extent those areas stabilize instream temperatures. In an example of how adult salmonid behavior is affected by declining temperatures in the winter, adult steelhead that overwinter in the upper-Columbia region are thought to generally seek refuge in the mainstem Columbia River. Some adults will also seek refuge in deep pools of the mainstem tributaries to the Columbia River (C. Peven, Chelan PUD, pers. comm., 2000) but may return to the Columbia River if instream water

temperatures become too harsh (L. Brown, WDFW, pers. comm., 2000).

The following spring, spring chinook juveniles (age-1 to age-2) and steelhead smolts (average age-2) exit the subbasin and begin seaward migration. Flows, food and cover that provides protection from predators are critical. Once again the unique natural flow regime in each river subbasin which shaped the population's characteristics through adaptation over the last 10,000 years, plays an important role in the salmonids behavior and survival. However, salmonids from the upper-Columbia region must migrate through a river system that has been highly altered by hydroelectric development. Hydropower dams converted the free-flowing Columbia River to a series of five reservoirs from the site of Priest Rapids Dam (RM 397.0), located downstream of the town of Vantage near the Yakima/Benton county line, upstream to the Chief Joseph Dam (RM 545.1) located upstream of the Okanogan River confluence (RM 533.1). The construction of water storage reservoirs on the mainstem of the Columbia River altered the migration habitat of salmonids in the Columbia River system. Altered flows and river temperatures could interfere with salmonid life histories stages cued to the normal flow and temperature patterns (Lichatowich and Mobrand 1995). Depending on species, this alteration may have varying affects on survival during migration, correlating to the timing and duration of migration through the reservoirs and the size of juveniles during migration. For example, in reservoirs, the principal mechanism that causes smolt mortality associated with speed through reservoirs is thought to be predation (Chapman et al. 1995a). Therefore, migrational delays created by reservoirs theoretically increases the length of time for which smolts remain exposed to predation within reservoirs (Chapman et al. 1995a). The extent of mortality caused by predation may vary from spring through summer, increasing throughout the summer as water temperatures and corresponding predator activity increase (Chapman et al. 1995a). This can be translated to mean spring chinook and sockeye smolts likely incur lower mortality rates from predaceous fish than summer migrants (Chapman et al. 1995a) like summer chinook and steelhead. On the other hand, subyearling summer chinook salmon produced in upper-Columbia tributaries, which do not migrate into the Columbia River until early June (Chapman et al. 1994a), tend now to spend several weeks in the reservoirs before they arrive at Priest Rapids Dam in August and later. This has substantially increased the mean size of subyearlings at time of passage at Priest Rapids Dam (Chapman et al. 1994a). Delayed movement, coupled with rapid growth, has unknown effects on survival of summer/fall chinook subyearlings. The effect may be beneficial, to the degree that mainstem reservoirs substitute for estuarine rearing. Conversely, delay may be detrimental if it leads to increased predation rates (Chapman et al. 1994a).

Once reaching the estuary, that food-rich environment provides an ideal area for rapid growth. Adequate natural habitat such as eelgrass beds, mudflats, and salt marshes must exist to support the detritus-based food web. Also, the ecosystem processes that contribute nutrients and woody debris to these environments must be maintained to provide cover from predators and to sustain the food web. Common disruptions to these habitats include hydroelectric dams, dikes, bulkheads, dredging and filling activities, pollution, and alteration of downstream components such as woody debris and sediment loads.

The distribution, seasonal abundance and migratory behavior of salmon and steelhead, exiting the estuary for the nearshore and offshore ocean rearing environment varies considerably (Groot and Margolis 1991; Chapman et al. 1994b; Chapman et al. 1995a). For example, the movements of chinook at sea are more complicated than those of sockeye, and ocean residence for spring chinook is 2-3 years compared to 3-4 years for summer/fall chinook. Also, first-year chinook remain along the continental shelf north to the Gulf of Alaska more than other first-year salmon species (Chapman et al. 1995a). In contrast, distribution of young steelhead differ in time and space from any salmon. Steelhead do not remain along the coastal belt but move directly seaward during their first ocean summer (Chapman et al. 1994b).

In addition to the relationships between various salmonid species and their habitats, there are also interactions between the species that have evolved over the last 10,000 years. These interactions represent a delicate balance affected by habitat quality and habitat quantity. This relationship is complicated by the introduction of non-native salmonid species (brook trout), the introduction of salmonid hatchery stocks, planting of hatchery fish, the extirpation of native coho stocks, and potentially the reintroduction of hatchery coho stocks (BPA 1999) in the upper-Columbia region. Species like salmon, steelhead/rainbow, and bull trout exhibit a variety of life history patterns often as a result of their adaptability to a complex and fluctuating environment. Maintaining access to sufficient quantities of high quality habitat can contribute to supporting multiple life history stages for all species, thereby increasing a population's resiliency to environmental changes whether natural or human-induced (Lestelle et al. 1996).

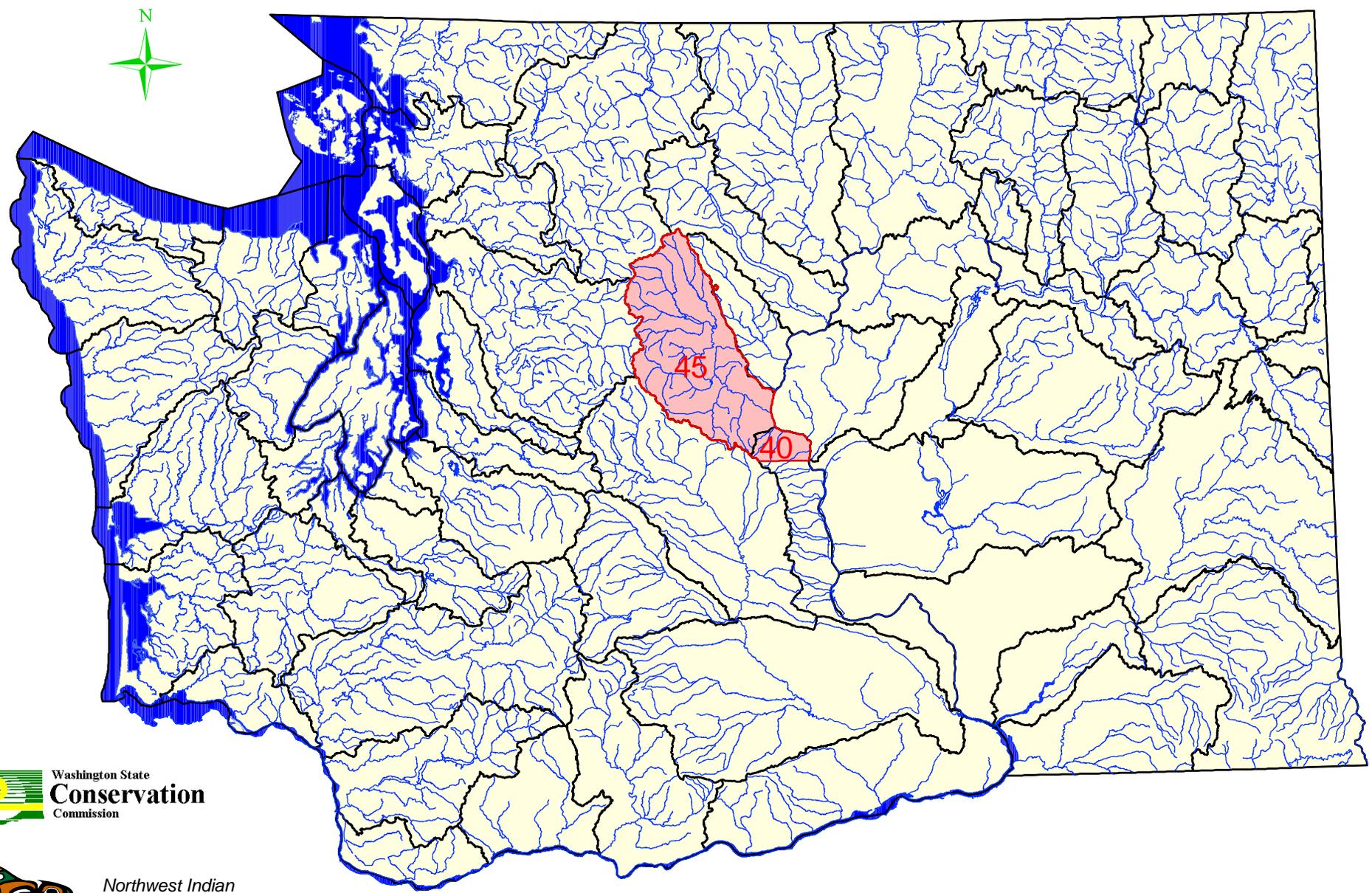
## **SUBBASIN DESCRIPTION**

### **Area Description**

The Wenatchee River drains a portion of the east slopes of the Cascade Mountains in north central Washington within Chelan County. The river flows generally in a southeasterly direction, emptying into the Columbia River at the City of Wenatchee at Columbia River Mile (RM) 468.4. The Wenatchee River subbasin (WRIA 45) encompasses approximately 1,371 square miles (877,40 acres), with 230 miles of major streams and rivers, not including those portions of WRIA 45 that drain directly into the Columbia River (CCCD 1996). The subbasin originates in high mountainous regions of the Cascade Mountains, with numerous tributaries draining subalpine regions within the Alpine Lakes and Glacier Peak wilderness areas. It is bounded on the west by the crest of the Cascade Mountains, on the north and east by the Entiat Mountains, and to the south by the Wenatchee Range. The Little Wenatchee and White Rivers flow into Lake Wenatchee, the source of the Wenatchee River. From the lake outlet at Wenatchee RM 54.2 the river descends rapidly through Tumwater Canyon, dropping into a lower gradient section in the region of Leavenworth, where Icicle Creek joins the mainstem (RM 25.6). Other major tributaries include Nason Creek (RM 53.6), the Chiwawa River (RM 48.4), Chumstick (RM 23.5), Peshastin (RM 17.9), and Mission (RM 10.4) creeks. The WRIA 45 also includes areas on the west side of the Columbia River extending from the south part of the City of Wenatchee at Dry Gulch (RM 464.6) northward to Rocky Reach Dam (RM 473.7). This portion of WRIA 45 is not included in the limiting factors report since the streams in this area are all seasonal and do not support salmonids. Figure 2 shows the location of WRIAs 45 and 40 in the state.

The Squilchuck, Stemilt, and Colockum watersheds (96,882 acres combined) are located in the northernmost portion of WRIA 40 where it extends into Chelan County from the south. The watersheds drain northeastward directly into the Columbia River. They are bounded on the west by Naneum Ridge and Mission Ridge, on the south by Jumpoff Ridge, and on the east by the Columbia River, and on the north by the Columbia River, Beehive Mountain and Dry Gulch. The remainder of WRIA 40 extends southward into Kittitas County with tributaries draining into the Columbia River. This portion of WRIA 40 is not included in this limiting factors report.

**Figure 2: Location of WRIAs 45 and 40 (N. Part Only) in The State**



**Location of WRIAs 45 & 40 (north part only) outlined in Red**

## **Climate and Precipitation**

The Cascade Mountains and the prevailing westerly winds are the dominant climatic factors influencing the subbasin. Moist air from the Pacific Ocean uplifts and cools as it moves east over the mountains. Most precipitation occurs in late fall and winter. The Cascade Mountain area is characterized by heavy precipitation, with nearly 150 inches annually. Most of the precipitation occurs during the winter months as snow. Snow depths in the mountains range from 10 to 20 feet and snow covers the mountain areas from late fall through early summer. Temperatures at Wenatchee range from a January mean of 26.2 °F to a July average of 73.4 °F (CCCD 1998). As air masses move east toward the Columbia Basin, moisture progressively decreases, resulting in arid conditions within the lowermost region of the subbasin and in the WRIA 40 watersheds. In contrast to the mountainous areas, the City of Wenatchee receives 8.5 inches or less of precipitation annually with maximum summer temperatures averaging 95° F to 100° F. Violent summer thunderstorms occur periodically, and can result in flash flood conditions on local watersheds (Montgomery Water Group et al. 1995).

## **Geology**

The waters of the Wenatchee River flow from and through the most diverse occurrence of rock types of any river in Chelan County. Glacier ice carved the pathway, allowing the river and its tributaries to cross many geologic boundaries. The immense elevation difference between the town of Wenatchee (615 feet) and Stuart Peak (9,470 feet), which straddles the Icicle and Peshastin watersheds, was created by the uplifting of the Cascade Mountains and the down-cutting of the Columbia River.

The last large scale glaciation occurred more than 10,000 years ago. For thousands of years snow accumulation continued to exceed snow melt and, as a result, large masses of ice gradually moved from higher elevations downslope. As they moved, one layer would combine with another and another until the combined weight and abrasive features were sufficient to cut down through any rock mass. The glaciers also provided huge amounts of melt water that flowed downstream towards the Columbia River creating outwash deposits which are composed of deep deposits of silt, sand, and gravel. The large volume of water moved tons of rocks and gravel that scoured out the sandstone formations where they occurred from Dryden to the Columbia River. More recently rivers have scoured the bedrock and glacial deposits and redeposited them as sand and gravel terraces and plains (CCCD 1996). A review of well logs indicates sediments thicken to over 170 feet along the main axis of the Lake Wenatchee valley (Economic and Engineering Services and Golder Associates 1998). In some places within the subbasin, (near the confluence of Icicle Creek and the Wenatchee River), the deposits may be up to 300 feet (M. Karrer, USFS, pers. comm., 2001).

In contrast, the portion of WRIA 40 included in this report, as well as the area extending up to the mouth of the Wenatchee River and then west to a point just east of State Highway 97, was covered by massive basalt flows during the Miocene epoch. (41 – 11 million years ago). The basalt flows overlaid more easily weathered, sandstone formations, which during the extremely wet and warmer Pleistocene climate (post glaciation), provided an adequate amount of water through fracture lines in the overlaying basalt to decompose old sediment formations underneath (USFS 1998j). This subsequent weathering and failure has resulted in very large, valley-filling, mass wasting deposits, the genesis of the types of highly porous soils that can be found in this area of Chelan County.

## Water Resources

### Hydrology

Most of the streamflow in the Wenatchee subbasin originates from several large tributaries in the upper portion of the subbasin. Five tributaries – the Chiwawa River, the White River, the Little Wenatchee River, Nason Creek and Icicle Creek – are the source of over 94% of the surface water within the subbasin, whereas their drainage area represents only 58% of the total subbasin (Montgomery Water Group et al. 1995). The major tributaries and their approximate percentage contribution to the annual flow of the Wenatchee River at its mouth (based on average flows) are as follows (Table 2):

**Table 2: Percent contribution by watershed to annual flow of the Wenatchee River at the mouth.**

Watershed	Percent Contribution	
	WIRPP <sup>1</sup>	Hindes <sup>2</sup>
White River	25	26
Little Wenatchee River	15	13
Chiwawa River	15	17
Nason Creek	18	12
Icicle Creek	20	19
Chumstick Creek	* 3	0.2
Peshastin Creek	* n/a	4
Mission Creek	1	0.5
Other minor sources	3	** 8.3

<sup>1</sup> WDOE. 1982. Wenatchee River Basin Instream Resources Protection Program. WIRPP Series No. 26, Water Resources Policy Development Section, Olympia, WA. WDOE (1982, pg. 7) estimated % contributions to annual flow of the Wenatchee River at its mouth, based on average flows of the tributaries.

<sup>2</sup> Hindes, R. 1994. Wenatchee River Watershed Ranking Project, Watershed Characterization and Ranking Report. Prepared for the Chelan County Conservation District, Wenatchee, WA. Hindes (1994, pg. 18) based % contribution to annual flows of the Wenatchee River on flow measurements made at each tributary from Oct. 1992 to Sept. 1993.

\* Chumstick and Peshastin creeks are combined.

\*\* Reflects the difference between the total acre feet of water measured at the tributaries and the total discharge on the Wenatchee River at Monitor.

Minimum instream flow were established for the Wenatchee River at the towns of Plain, Peshastin and Monitor, and near the mouth on Icicle Creek and on Mission Creek (Chapter 173-545 WAC). These flows are not often met during the winter and late summer as a result of natural low flows and out-of-stream water use (CCCD 1998). With few exceptions, these instream flow requirements do not affect water rights that were established prior to 1983 (CCCD 1998).

### Aquifer Characteristics<sup>1</sup>

Groundwater in the Wenatchee River subbasin is present in two major flow systems; a bedrock flow system and a surficial flow system present in sediments overlying bedrock. While many domestic wells within the subbasin do penetrate bedrock, yields are generally low, less than one gpm. Some bedrock wells reportedly have yields up to 15 gpm. The bedrock wells are not considered viable sources for significant groundwater development. Many of the domestic wells penetrating bedrock have found reliable sources of water contained in the sandstone. Often a thin zone of relatively high permeability weathered bedrock may be present, that also contains enough water for domestic development. Recharge to bedrock aquifers is derived from direct precipitation on bedrock outcrops, and from overlying glacial deposits.

The alluvial and glaciofluvial outwash sediments that fill river valleys and depressions in the bedrock, are a source for much of the domestic and public water supply. The town of Cashmere is rests on alluvial materials and local ground water wells provide the primary source of water supply to the town (WDOE 1982). The nature and extent of these fill materials is highly variable, with reported areas of confined aquifer conditions due to overlying lacustrine silts and clays. Well yields in the fill materials reportedly range from less than 5 gpm to over 100 gpm. Recharge to the aquifers is primarily in the form of precipitation infiltration, surface water infiltration, and recharge from deeper bedrock aquifers. Groundwater flow is likely in a down valley direction. Some localized aquifers, such as those found in smaller drainages above the Wenatchee River Valley, will likely be more affected by increased groundwater usage than the larger aquifers located in the Wenatchee River Valley. This is because recharge is limited by the small drainage size and low amounts of precipitation occurring in those drainages.

### Groundwater\Surface Water Interaction<sup>1</sup>

Reports indicate that groundwater and surface water interact throughout the subbasin, depending on the sub-area's morphology. Many of the smaller drainages have aquifers in valley fill that are in direct connection with surface water and the water levels generally respond together. Generally, wells drilled into the alluvium adjacent to a watercourse may tap water which is in direct hydraulic continuity with a stream. In this instance, the

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<sup>1</sup> This section contains language almost exclusively from, Montgomery Water Group et al. 1995.

surface water supply can be diminished when the well is pumped (WDOE 1982). In all cases, interaction between surface water and groundwater within the subbasin is largely dependent on the highly variable geologic conditions. Generally, increased withdrawal from groundwater will result in a decrease in recharge to surface water at some point. Ultimately, most all groundwater within the subbasin eventually flows to surface water or another aquifer.

## **Vegetation <sup>2</sup>**

Extreme variations in elevation, precipitation, and geology, as well as influences of glaciation, have provided great diversity in plant communities within the Wenatchee subbasin. Forested plant communities occupy the majority of the landscape in the subbasin with relatively small amounts of non-forest vegetation in both the highest and lowest elevations. Plant communities range from shrub-steppe at the lowest elevations through mostly forested areas at lower to upper elevations, and finally to alpine meadow communities at the highest elevations.

The watersheds within the Wenatchee subbasin differ in their climates based primarily upon their proximity to the Cascade Mountain Crest. Those close to the crest experience strong maritime climatic influences as maritime air incursions occur. The watersheds that experience less effect from west-side climatic conditions, either by distance or by other mountain ranges, are more continental (arid) in their climatic character. Generally, the Mainstem Wenatchee, Mission, Chumstick, and Peshastin watersheds, as well as the Squilchuck, Stemilt and Colockum watersheds of WRIA 40, support vegetation that is more continental in nature. The White, Nason, Chiwawa, and Little Wenatchee support more maritime influenced vegetation. The Icicle watershed supports significant amounts of both maritime and continentally influenced vegetation. In general, the plant species that require more maritime conditions will drop out to be replaced by species indicative of more arid climates.

Climate in the Wenatchee subbasin also differ with elevation. The northern-most watersheds of the Wenatchee subbasin are most influenced by maritime influences at the higher elevations with precipitation decreasing with decreasing elevation. Since the upper Wenatchee subbasin watersheds also have the highest portion of their area in high elevation, these watersheds typically have little low-elevation shrub-steppe habitat. Conversely, in the more arid areas within the subbasin further removed from the Cascade Crest, there is a higher percentage of low elevation shrub-steppe vegetation and/or dry open forest. The watersheds with larger proportions of area over about 7000 feet generally support more alpine shrub and meadow lands.

The forest zones that predominate in maritime areas include mountain hemlock, silver fir and western hemlock. These are typically characterized by areas of dense forest and

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<sup>2</sup> This section contains language almost exclusively from, CCCD. 1996.

relatively high precipitation. Understory plants are numerous and may include cascade huckleberry, rusty menziesia, devil's club, rosy twistedstalk, and coolwort foamflower. Mountain hemlock, whitebark pine and subalpine larch form open forests at the extreme upper elevation limit of trees. Cascade huckleberry is usually an important understory species in these areas. Vegetated alpine areas are dominated by various shrubs and herbs. Often wet alpine areas support a higher percentage of herbaceous vegetation while well-drained alpine areas support shrubs such as red mountain heath and moss-heathers. Dry alpine areas grasslands are limited in extent.

In areas with more arid influence, mountain hemlock, silver fir, and western hemlock are uncommon or absent. Forest areas are dominated at climax by such trees as subalpine fir, grand fir, douglas fir, or ponderosa pine. Understory species are numerous, and may include pinegrass, elk sedge, heartleaf arnica, dull oregon grape, bigleaf sandwort, vanilla leaf, oceanspray, serviceberry, and lupine. The lowest elevation non-forest areas are commonly dominated by bitterbrush, bluebunch wheatgrass, arrowleaf balsamroot, yarrow and various other dry site species. Subalpine larch and whitebark pine usually comprise the open forests at extreme upper elevations, often with subalpine fir intermixed or present just lower in elevation. Cascade huckleberry is typically absent and often replaced by grouse huckleberry. Vegetated alpine areas can again be moist herb dominated communities or drier shrub or grasslands. High elevation dry grasslands (usually dominated by green fescue) are more common here than in strongly maritime areas.

Within these major plant community types, riparian areas around streams, lakes, wetlands, small meadows and forest openings are interspersed. More moisture dependent species such as willows and sedges can be found in the wet areas while dry forest openings support either forest understory species or plants from drier plant communities common to lower elevations. In riparian plant communities, aspen, black cottonwood, bigleaf maple, alder, and red-osier dogwood are common.

Past and present land uses have altered the landscape. Sheep grazing, especially in the late 1800's and early 1900's, has contributed to altering the natural plant community. Logging and agriculture (primarily orchards) are ongoing uses that have changed the subbasin's vegetative makeup. Residential land use is having a significant impact on the vegetative character of some watersheds. Fire suppression has caused important changes in some areas of the subbasin. In middle to lower elevation arid areas, the historic fire interval was often short (usually 10-50 years). Fire suppression has led to an increase in tree density in some areas as well as increased abundance of more shade tolerant trees such as grand fir. In higher elevation and/or more maritime areas, where historic fire intervals were longer (usually 50-200+ years), the short time since effective fire suppression began may not have allowed for significant change in stand densities or composition when compared to historic conditions.

The establishment of exotic plants is having a significant impact on the vegetation of the subbasin. Weed species such as cheatgrass, knapweed, dalmation toadflax, and purple

loostrife have become established in some areas and can exclude native vegetation particularly in non-forest, riparian or open forest conditions.

A number of the most rare plants in the state are present in the subbasin including showy stickseed, Wenatchee larkspur, Oregon checkmallow, clustered lady's slipper, several grapeferns, Thompson's chaenactis, bristly sedge, bulb-bearing waterhemlock, pine broomrape, Ross' avens, and long-sepaed globe mallow. A number of other sensitieve plants are also found in the subbasin.

### **Land Use and Ownership**

The primary land uses within the Wenatchee River subbasin are forestry, wilderness, agriculture, range, residential, and recreation. The federal government is the largest landowner in the subbasin, with approximately 671,220 acres (76 % of the subbasin; CCCD 1996) under the management of the USFS. The BLM manages a very small area of the subbasin, approximately 200 acres. The majority of federal lands lies in the upper and middle portions of watersheds and in those watersheds located in the northern portion of the subbasin. The largest portion of USFS land (316,561 acres) is designated Wilderness (47%). The DNR manages approximately 8,700 acres in the subbasin; Longview Fibre company managers estimate their timber company manages 47,760 acres (CCCD 1996). Only 17 % of the subbasin is privately owned (excluding Longview Fibre lands), totaling 149,560. Privately owned lands occurs mostly in the low lying valley bottoms and more private land is located in the southern portion of the subbasin next to the Wenatchee River and along its major tributaries.

## FISH DISTRIBUTION AND CONDITION

### Summary of Historic Events

The rivers of the Upper Columbia basin historically were excellent salmonid producing streams. There were formerly good runs of steelhead trout, spring chinook, and summer chinook salmon in the Wenatchee subbasin. Sockeye salmon ran into Lake Wenatchee and a good run of coho salmon spawned in the Wenatchee system (Bryant and Parkhurst 1950). Bull trout were also distributed throughout the subbasin in their various life history forms. However, by the 1930's, the anadromous runs were decimated because of overfishing in the lower Columbia River fisheries, irrigation diversion practices in the watershed, and habitat degradation related to poor mining practices, grazing, and logging (Craig and Suomela 1941, Fish and Havana 1948; Bryant and Parkhurst 1950; Mullan et al. 1992; Peven 1992). Bull trout populations may have also been impacted by habitat fragmentation as a result of irrigation diversions dewatering lower reaches and diversion dams creating impassable barriers.

From the 1930's to present, the development of the Columbia River for hydroelectric power production, hatchery mitigation programs, fishing harvest pressures, degradation of tributary habitats, and the loss of Columbia River estuary rearing areas for juvenile anadromous salmonids have contributed to suppressing naturally producing anadromous salmonid runs in the Upper Columbia (Peven 1992; Mullan et al. 1992). With the construction of the Grand Coulee Dam in 1939, anadromous salmonids were barred from 1,140 miles of potential spawning and rearing habitat in the upper Columbia River drainage (Fish and Havana 1948). Between 1939 and 1943 all adult salmon and steelhead were intercepted at Rock Island Dam downstream of the town of Wenatchee, for brood stock as part of the Grand Coulee Fish Maintenance Project (GCFMP). The various tributary stocks of each species were mixed in the hatchery program with the resultant young being released throughout the Wenatchee, Entiat, Methow and Okanogan River drainages.

Meanwhile, Columbia River harvests continued to take a heavy toll on returning adults. A harvest rate approaching 85% in the 1930's and 1940's was estimated in the lower Columbia River fisheries (Mullan 1987). Aside from harvest impacts, habitat alterations in the Columbia River estuary were impacting rearing juveniles, and in the Wenatchee subbasin, logging, water diversions, and grazing impacts were negatively affecting rearing and spawning success. As more hydroelectric facilities on the upper Columbia River became operational, alterations and adjustments to the hatchery supplementation program were made. Still, wild salmon and steelhead returns continued to decline.

By 1971, seven dams were in place on the Columbia River between the mouth of the Columbia River and the Wenatchee River confluence at RM 468.4. The first dam upstream from the mouth of the Columbia River is Bonneville Dam (RM 146.1),

followed by five more hydroelectric dams (Dalles Dam/RM 191.5; John Day Dam/RM 215.6; McNary Dam/RM 292.0; Priest Rapids Dam/RM 397.0; Wanapum Dam/RM 415.8) before reaching Rock Island Dam at RM 453.4, fifteen miles downstream of the mouth of the Wenatchee River. Upstream of the Wenatchee River confluence, there are two more dams, Rocky Reach Dam (RM 473.7) and Wells Dam (RM 515.6) before reaching Chief Joseph Dam at RM 545.1 which does not have a fish passage facility and therefore is the current upper-most extent of anadromy on the Columbia River.

Meanwhile, in the Wenatchee subbasin, timber harvests were in full swing. Road densities and riparian harvests associated with past logging operations continue to be an impact today in regard to fish passage, water runoff patterns, sediment delivery to streams, large woody debris (LWD) recruitment, and stream function. The full extent of water diversions and withdrawals on habitat condition and fish production in the subbasin are still not fully known although management practices, including water use and delivery systems by irrigation districts have improved and likely resulted in decreased impacts to salmon production over historic conditions. The conversion of floodplain habitat to urban and residential use, including flood control, continue to have an impacts on stream function and salmonid production while the decline of beaver, the loss of the nutrient input from salmon carcasses and the introduction of Eastern brook trout continue to negatively impact habitat conditions.

### **Current Distribution, Status, and Species Life History Description**

Appendix A contains five maps showing the current distribution of spring chinook, summer chinook, steelhead/rainbow trout, sockeye and bull trout. It reflects knowledge current as of April 2001. All upper extents of distribution should be considered approximate. The five tables (one for each species) in Appendix B provide more detailed information on the source of the fish distribution data shown in the distribution maps.

The information for all fish species distribution was derived from: 1) WDFW StreamNet; 2) USFS Okanogan-Wenatchee National Forest fish distribution database; 3) Chelan County PUD spawning ground survey reports; and 4) professional knowledge and observation from TAC participants including Bob Steele, Area Habitat Biologist, WDFW; Art Viola, Area Fish Biologist, WDFW; Dan Rife, Fish Biologist, USFS; and Steve Tift, Biologist, Longview Fibre. The Chelan County Watershed Program GIS Specialist, Sarah Merkel, in cooperation with the Washington State Conservation Commission, compiled the data and developed the GIS fish distribution layers with associated data tables.

Appendix C contains a table provided by Chuck Peven, Chelan County PUD, summarizing historic spring chinook redd counts from 1958 – 1999. The data is based on annual spawning ground surveys conducted by the Chelan PUD during that period and helps illustrate the relative importance of watersheds to spring chinook production.

## **Bull Trout**

The Upper Columbia Distinct Population Segment (DPS) of bull trout was listed as threatened under the federal Endangered Species Act (ESA) on June 12, 1998. The 1998 Bull Trout and Dolly Varden Appendix to the Washington State Salmonid Stock Inventory (SaSI; WDFW 1998a) identifies 11 bull trout/dolly varden stocks in the Wenatchee subbasin. (NOTE: Although the WDFW SaSI Appendix (1998a) refers to bull trout in the mid-Columbia River basin as “bull trout/dolly varden”, Proebstel et al. (1998) provided conclusive evidence that bull trout (*Salvelinus confluentus*) are clearly distinct from dolly varden (*Salvelinus malma*) in the mid-Columbia basin.) They are the Icicle, Ingalls, Chiwaukum, Chikamin, Rock, Phelps, Nason, Panther, Little Wenatchee, Chiwawa and White River stocks. The WDFW Salmonid Stock Inventory, Bull Trout & Dolly Varden Appendix (1998a), referred to a “Napeequa population”, and reported it was thought to be extinct. However, large bull trout have been observed in the Napeequa River by USFS personnel during snorkeling surveys, although spawning activity has not been observed (MacDonald, USFS, pers. comm., 2001). Four of the 11 stocks have been classified as “Healthy” (Chikamin, Rock, Phelps, Panther) with the remaining 7 listed as “Unknown” based on the trend of abundance data available at the time the classifications were made. The SaSI Appendix also makes the following statement; “Nearly all suitable spawning habitat is currently used by bull trout/Dolly Varden and present spawning distribution is nearly the same as the distribution prior to European settlement” (WDFW 1998a). This seems to be in conflict with the information presented by the TAC which indicates a loss of fluvial bull trout life history forms associated with the Peshastin and Icicle watersheds.

Four general forms of bull trout are recognized, each with a specific behavioral or life history pattern; anadromous, adfluvial, fluvial, and stream-resident. The Wenatchee subbasin supports all life history forms except anadromous. Historically, these three forms were probably dispersed throughout the Wenatchee subbasin with distribution and population levels dictated by temperature and gradient. The adfluvial form matures in lakes and ascends tributary streams to spawn, where the young reside for one to three years. Lake Wenatchee supports an adfluvial population which spawns in both the White and Little Wenatchee rivers. Fluvial bull trout have a similar life history except they move from rivers to smaller tributaries to spawn. Presently fluvial populations spawn in the Wenatchee River, Nason Creek, the Chiwawa River, and Rock Creek, Chikamin Creek and Phelps Creek (all tributaries to the Chiwawa River). Adfluvials and fluvials often make extensive migrations, usually do not reach sexual maturity until age five or six, and can reach a size exceeding 22 pounds (Fraley and Shepard 1989). In the Wenatchee River, bull trout up to 32-36 inches and 12-15 pounds have been observed (Brown 1992). Non-migratory, stream-resident bull trout spend their lives in headwater tributaries, apparently migrating very little, and seldom reach a size of over 14 inches. Resident populations currently exist in Panther Creek and the Napeequa River (both tributaries to the White River), in Jack, Eightmile, and French Creeks of the Icicle watershed, and Ingalls Creek, a tributary to Peshastin Creek.

Bull trout are strongly influenced by water temperature during all life stages and for all forms. Most bull trout spawn from mid-September through October, with timing related to declining water temperatures. In high elevation, cold waters, spawning has been documented to start as early as August in the upper Yakima system (elevation 3,500 feet; Brown 1992). Adult redd site selection is determined by substrate size and quality, hiding cover, streamflow, and ground water sources (Spotts 1987, Baxter et al. 1999). Spawning sites are commonly found in areas of ground water interchange, both from the subsurface to the river, and from the river to the subsurface. Association with areas of ground water interchange can promote oxygen exchange and mitigate severe winter temperatures including the formation of anchor ice. Incubation time to hatching has been documented at approximately 113 days, with emergence about 223 days from the date of deposition, temperature dependant (Brown 1992). Fry have been documented to remain in the gravel for three weeks after emergence (McPhail and Murray 1979). The long over-winter phase for incubation and development leaves bull trout vulnerable particularly to increases in fine sediment, especially during snow-melt events, and degradation of water quality (Fraley and Shepard 1989).

Good hiding cover is also important to all life stages of all forms of bull trout. Juvenile bull trout, particularly young-of-the-year (YOY), have very specific habitat requirements. Bull trout fry less than 4 inches are primarily bottom-dwellers, often found on margins over fine depositions of detritus ( J. Molesworth, USFS, pers. comm., 2000). They occupy positions just above, in contact with, or even within the substrate. Fry and juveniles can be found in pools or runs in close proximity with cover provided by boulders, cobble, or large woody debris. Age 1+ and older juveniles utilize deeper, faster water than YOY, often in pools with shelter-providing large organic debris or clean cobble substrate. In large rivers, the highest abundance of juveniles can be found near rocks, along the stream margin, or in side channels. Fluvial populations overwinter in deep pools with boulder-rubble substrate or move further downstream to lower reaches of mainstem rivers where individuals make use of abundant woody debris and overhanging banks.

## **Coho Salmon**

Indigenous coho salmon no longer occur in the Upper Columbia River region. As an extirpated species, the Wenatchee subbasin coho run is not addressed under the federal ESA or the Washington State Salmon and Steelhead Stock Inventory (SASSI; WDF/WDW 1993). The ESA and SASSI do not address extinct or extirpated stocks.

Because the historical stocks of coho were decimated in this region near the turn of the century, most life history information was obtained through affidavits from older residents. The historical information supports the theory that these fish were probably early-returning-type adults, ascending the mid-Columbia tributaries in August and September (Mullan 1983).

Lower Columbia River early-returning-type hatchery coho salmon spawn from October to mid-December. Columbia River coho salmon typically spend one year in freshwater before outmigrating as yearling smolts in the spring (April/May). After outmigrating, coho salmon spend approximately 18 months at sea before returning to spawn. Sexually precocious males (jacks) return to spawn after six months at sea (BPA et al. 1999).

In the rest of Washington State, the onset of coho salmon spawning is tied to the first significant fall freshet. They typically enter freshwater from September to early December, but have been observed as early as late July and as late as mid-January. They often hold near the river mouths or in lower river pools until freshets occur. Spawning usually occurs between November and early February, but is sometimes as early as mid-October and can extend into March. Spawning typically occurs in tributaries and sedimentation in these tributaries can be a problem, suffocating eggs. As chinook salmon fry exit the shallow low-velocity rearing areas, coho fry enter the same areas for the same purpose. As they grow, juveniles move into faster water and disperse into tributaries and areas which adults cannot access (Neave 1949). Pool habitat is important not only for returning adults, but for all stages of juvenile development. Preferred pool habitat includes deep pools with riparian cover and woody debris.

Coho juveniles remain in the river for a full year after leaving the gravel nests. As with all salmonids, low flows during the summer after early rearing, can lead to problems such as a physical reduction of available habitat, increased stranding, decreased dissolved oxygen, increased temperature, and increased predation. Juvenile coho are highly territorial and can occupy the same area for a long period of time (Hoar 1958). The abundance of coho can be limited by the number of suitable territories available (Larkin 1977). Streams with more structure (logs, undercut banks, etc.) support more coho (Scrivener and Andersen 1982), not only because they provide more territories (useable habitat), but they also provide more food and cover.

In the autumn as the temperatures decrease, juvenile coho move into deeper pools to hide under logs, tree roots, and undercut banks (Hartman 1965). The fall freshets redistribute them (Scarlett and Cederholm 1984), and over-wintering generally occurs in available side channels, spring-fed ponds, and other off-channel sites to avoid winter floods (Peterson 1980). As coho juveniles grow into yearlings, they become more predatory on other salmonids. Coho begin to leave the river a full year after emerging from their gravel nests with the peak outmigration occurring in early May.

By the early 1900's coho salmon populations were already decimated by lower Columbia River harvest rates, impassable dams, unscreened irrigation diversions, logging, mining, grazing, and water use practices in the tributaries (BPA et al. 1999). As mitigation for lost production resulting from the development of hydroelectric facilities on the Columbia River since the 1930's, forty-six million fry, fingerlings, and smolts from Leavenworth, Entiat, and Winthrop National Fish Hatcheries were planted in the mid-Columbia basins between 1942 and 1975 (BPA et al. 1999). Despite this effort, self

sustaining coho populations were not established for several reasons: construction and operation of Columbia River hydroelectric facilities; habitat degradation; and poorly administered coho hatchery programs (BPA et al. 1999). From 1933 to 1943 only 475 coho salmon were counted at Rock Island Dam, which counted fish bound for the Wenatchee, Entiat, Methow and Okanogan river systems. Mullan (1983) estimated historical adult coho populations in the Wenatchee subbasin at 6,000 to 7,000.

The Yakama Nation (YN) has prepared a Final Environmental Assessment (BPA et al. 1999) on the feasibility of reintroducing coho salmon to the mid-Columbia region. Their goal is to restore natural production as identified in the Yakama Nation's "Coho Salmon Species Plan" (CSSP) for the Mid-Columbia Basin. The goal of this program is to initiate restoration of coho salmon populations in mid-Columbia tributaries to levels of abundance and productivity sufficient to support sustainable annual harvest by tribal and other fishers. The proposed acclimation sites in the Wenatchee subbasin for reintroduction of yearling coho under the Tribal Alternative are; Nason Creek (at Swamp and Butcher creeks), Little Wenatchee and White rivers (White River Side Channels and Two Rivers), Icicle Creek (Hatchery Side Channel or Pond), Wenatchee River (Chiwaukum Creek). Only a maximum of three of these six proposed sites will be used. The Mid-Columbia Conservation Plan (MCMCP 1998) considers the reintroduction of coho salmon to be outside the scope of their plan and will consider artificial propagation of coho only once natural populations are re-established.

## **Sockeye**

Sockeye were once widespread and abundant in the Columbia River system, including the upper Columbia area now blocked by the Grand Coulee Dam. Neither of the two stocks that remain in the Upper-Columbia River region, the Wenatchee and the Okanogan, are listed under the ESA. The SASSI lists the Wenatchee Sockeye Stock as "Healthy" based on escapement (WDF/WDW 1993). This sockeye run supports a popular fishery in Lake Wenatchee.

Sockeye salmon differ from other species of salmon in their requirement of a lake environment for part of their life cycle. Sockeye salmon have a wide variety of life history patterns, which include both anadromous (sockeye) and a non-anadromous (kokanee) forms. The distribution of sockeye salmon in the mid-Columbia region is limited to Lake Wenatchee (Wenatchee subbasin) and Lake Osoyoos (Okanogan subbasin). Limited numbers of adults and juveniles are periodically detected in the Methow and Entiat rivers (Carie 1996) and in isolated areas of the mid-Columbia River (Chapman et al. 1995b). Adult sockeye begin entering the Columbia River in May and pass the Mid-Columbia River dams between late May and mid-August (BPA 1994). Spawners reach Lake Wenatchee and Lake Osoyoos during July - September (Mullan 1986). Both sockeye populations from the mid-Columbia basin are fall spawners that begin spawning in September, with activity peaking in the Wenatchee system about the third week of September, and approximately a month later in the Okanogan River

(Howell et al. 1985). Statewide, spawning ranges from September through February, depending on the stock.

In the mid-Columbia region, after sockeye fry emerge from the gravel in the following early to late spring, they move to the nursery lake for rearing. Most sockeye in Lakes Osoyoos and Lake Wenatchee will reside in their lakes until the following spring, although some will remain for an additional year. Lake rearing in populations statewide ranges from 1-3 years. In the spring after lake rearing is completed, smolts migrate seaward where more growth occurs prior to adult return for spawning 1 to 3 (mostly 2 years) later (Schwartzbert and Fryer 1988). Sockeye salmon smolts typically pass the Mid-Columbia River dams between mid-April and late-May during their outmigration (Chapman et al. 1995b).

Sockeye are native to the Wenatchee subbasin but were drastically depleted by irrigation diversions and overfishing in the early 1900's (Peven 1992; WDF/WDW 1993). In the Wenatchee River system specifically, upstream passage conditions were historically a problem (Peven 1992). Prior to 1987, inefficient ladders at Dryden and Tumwater dams presented passage problems to adult fish. In 1986, fishways were rebuilt at both locations and passage problems have been eliminated to a large degree (Peven 1992). High flows in Tumwater Canyon may still cause a natural delay in upstream migration (Peven 1992).

The current population is a mixture of native sockeye and descendants of transfers during the Grand Coulee Dam Fish Maintenance Project (GCFMP) which began in 1939. Prior to 1939, Peven (1992) reported that the majority of the Columbia River sockeye run was thought to be produced in the upper Columbia River (above the Grand Coulee Dam site), with only small numbers of fish present in the Wenatchee and the Okanogan river systems. The GCFMP trapped all adult sockeye destined for the upper Columbia River, reared them at Leavenworth National Fish Hatchery, then released them into Icicle Creek or Lake Wenatchee. This was the beginning of the Leavenworth National Fish Hatchery (NMFS 2000b). Additionally, 2.4 million Quinault River sockeye were released into Lake Wenatchee as part of the project (WDF/WDW 1993). Sockeye production at the Leavenworth Hatchery was discontinued in 1969. Thereafter, no hatchery production of Wenatchee sockeye occurred until 1990 when juvenile sockeye from Wenatchee origin adults were released from net-pens in Lake Wenatchee.

Sockeye salmon counts at Rock Island have shown substantial variation since 1933 (ranging between 950 and 164,500). The counts were generally low between 1933 and 1945 (950 to 40,700), increased to between 4,700 and 164,500 through 1969, and between 14,750 and 109,000 through 1993. Since 1993 the counts have ranged between 8,500 and 41,500 (Chapman et al. 1995b; NMFS 2000a).

## **Summer Chinook**

The summer chinook run in the Upper Columbia is not listed under the ESA. The Washington State Salmon and Steelhead Stock Inventory (SASSI) has identified one summer chinook stock in the Wenatchee subbasin, the Wenatchee River summer chinook, and classified it as “Healthy” based on escapement. This run is one of the largest naturally produced chinook populations in the Columbia Basin. Only the fall chinook runs in the Hanford Reach and the Lewis River are larger (WDF/WDW 1993).

Chinook salmon have three major run types in Washington State – spring, summer and fall. Summer and fall runs of chinook are referred to as an “ocean-type” (Healey 1983) meaning they spend less than one year in freshwater before migrating to the ocean as subyearlings. Most of their life is therefore spent in the ocean. Relative to other populations, ocean-type salmonids spend the shortest amount of their life in the tributaries. An important factor that separates the summer chinook from anadromous salmonids is that juvenile fish have exited the subbasin prior to the lowest flows in fall and are not subject to harsh conditions in winter. However, there is evidence that some subyearling summer chinook exhibit a slow rearing migration and forage behavior as they pass the reservoir system, thereby delaying their arrival at the estuaries until they are yearlings and of a larger size (MCMCP 1998). This phenomenon suggests that mainstem reservoirs influence the success of ocean-type salmonids.

Most ocean-type chinook enter the Columbia River from late May to early July and pass the Mid-Columbia dams from late June through October (Peven 1992). Summer chinook salmon enter the Wenatchee River beginning in late June (WDF/WDW 1993). Spawning begins in late September and continues through early November (MCMCP 1998). Spawning reaches a peak in early to mid-October (WDF/WDW 1993). Eggs incubate in the gravel through winter with fry emerging from the substrate probably from January through April (MCMCP 1998) and rapidly emigrate from the mainstem Wenatchee River (Hillman and Chapman 1989a).

Historically, summer chinook were abundant in the middle to upper Columbia River and may have been the most plentiful of the chinook runs (Chapman 1986, Mullan et al. 1992). Historic runs size of summer chinook entering the Columbia River is difficult to determine. Chapman (1986) estimated that of the 3.8 to 4.3 million chinook entering the Columbia River, approximately 53% to 58% (2.0 to 2.5 million) of the run were summer chinook. These estimates were based on peak years of the harvest fishery in the 1880’s. Historic catch records show most of the fishing effort was concentrated in June and July (the summer chinook run time) until this large segment of the run was decimated from overfishing in the late 1880’s. The peak summer chinook catch in the early 1880’s averaged approximately 1.7 million fish (Chapman 1986). Fishing effort later targeted the other segments of the chinook run (spring and fall), and other species.

Summer chinook salmon counts at Rock Island dam averaged about 5,700 (adults and jacks) between 1933 and 1942; they remained less than 9,000 until 1951 and ranged between about 12,700 and 38,600 through 1998 (Chapman et al. 1994a; NMFS 2000a). In recent years (1994 to 1998) the counts at rock Island dam have averaged about 18,400 summer chinook (NMFS 2000a).

### **Spring Chinook**

The Upper Columbia Evolutionarily Significant Unit (ESU) of spring chinook was listed as endangered under the federal ESA on March 16, 1999. The Washington State Salmon and Steelhead Stock Inventory (SASSI) has identified four spring chinook stocks in the Wenatchee subbasin; the Chiwawa River, Nason River, Little Wenatchee River, and White River stocks (WDF/WDW 1993). All were classified as “Depressed” based on chronically low production.

Spring chinook are considered a “stream-type” salmonid (spending one or more years in freshwater). Migration into the Columbia River begins in late March to early April (WDF/WDW 1993) after spending 2 to 3 years in the ocean (Chapman et al. 1995a). Spring chinook enter the Wenatchee River from May to August (WDF/WDW 1993). Spawning begins in early August, peaks in mid-to-late August, and is completed by mid-September (WDF/WDW 1993). The eggs remain in the substrate and incubate through winter. The young (fry) emerge that following spring in April and May (WDFW et al. 1990) although juvenile salmon have been observed in the upper Methow River and the Chewuch drainage as early as the first part of March (Chapman et al. 1995a). The young will remain in freshwater environments for one year, not migrating out as smolts until the following spring (Healey 1991), passing the Mid-Columbia dams between mid-April and mid-June (NMFS 2000a). This extended freshwater period for both adults and juveniles makes spring chinook salmon more susceptible than the summer/fall (ocean-type) chinook salmon to impacts from habitat alterations in the tributaries.

The historic run size of spring chinook entering the Columbia River is difficult to determine. Most estimates are based on early commercial harvest. Chapman (1986) estimated that of the 3.8 to 4.3 million chinook salmon entering the Columbia River, 11-15 % of the run was spring chinook (420,000 to 650,000 fish). The peak commercial catch of spring chinook occurred between 1890 and 1895, after the earlier chinook fisheries had overexploited the larger, summer component of the run.

In 1935 counting of spring chinook began at Rock Island Dam (spring chinook were not counted in 1933 and 1934). Total runs of salmon were very low at this time (Peven 1992) with numbers in the period 1935 to 1938 as counted at Rock Island Dam less than 3,000 fish. This coincided with commercial catch rates in the lower Columbia River of up to 86% of the runs (Mullan et al. 1992). Following reduction of harvest and the initiation of the Grand Coulee Fish Management Plan (GCFMP) in 1939- 1943, counts of returning spring chinook increased at Rock Island Dam. The GCFMP did not allow for

any natural spawning of anadromous salmonids during that time, since all fish were collected for brood stock..

Numbers of spring chinook rose somewhat erratically to a peak of about 26,000 in the mid-1980's. The counts dropped off dramatically after 1993 and have averaged about 2,900 between 1994 and 1998 (Chapman et al. 1995; NMFS 2000a).

### **Summer Steelhead**

The Upper Columbia ESU of summer steelhead was listed as endangered under the federal ESA on August 18, 1997. The Washington State Salmon and Steelhead Stock Inventory (SASSI) identified one summer steelhead stock in the Wenatchee subbasin, the Wenatchee summer steelhead stock (WDF/WDW 1993). The stock is classified as "Depressed" based on chronically low production.

Steelhead have the most complex life history patterns of any Pacific salmonid species (Shapovalov and Taft 1954). Washington State has two major run types, winter and summer steelhead, determined by their freshwater entry time, although both runs are spring spawners. Winter steelhead adults begin river entry in a mature reproductive state in December and generally spawn from February through May. Dominating inland areas such as the Columbia Basin, summer steelhead adults enter the river from May through October after spending 1 to 2 years in the ocean (NMFS 2000a). These fish pass Rock Island Dam between July through May of the following year (counting at Rock Island ceases in November and resumes in April the following year), with the majority of fish passing between August and September. The fall migrants passing Rock Island Dam are thought to overwinter in the Columbia River and spawn the next spring. Summer steelhead are spring spawners with spawning beginning in March and continuing through June, although spawning has been known to occur as late as July in cold headwater tributaries (Fish and Hanavan 1948). Peak spawning is probably in late May (WDF/WDW 1993).

Time to hatching (incubation) varies with water temperature; the colder the temperature, the slower the developmental rate of the embryo and the longer time to hatching (Chapman et al. 1994b). Barnhart (1986) reported that the number of days required for steelhead eggs to hatch in the Pacific Southwest varied from 19 days at about 59° F (32.7°C) to 80 days at 41°F (22.7°C). Wydoski and Whitney (1979) reported that eggs hatch in about 50 days (in 50°F/10°C water). No one has assessed empirically the length of time required for naturally-produced steelhead to hatch in the mid-Columbia basin (Chapman et al. 1994b). Time from hatching to fry emergence from the gravels also varies depending on temperature and to a lesser extent other factors. Emergence of fry occurs late spring to August (NMFS 2000a). Mullan et al. (1992) indicates that median emergence time of steelhead fry in the coldest tributaries of the Upper Columbia River region occurs around September 15.

The length of time juvenile steelhead will spend rearing in freshwater before beginning seaward migration is mostly a function of water temperature (Mullan et al. 1992). Most fish that do not emigrate downstream early in life from the coldest environments are thermally-fated to a resident (rainbow trout) life history regardless of whether they were the offspring of anadromous or resident parents (Mullan et al. 1992). Smoltification may occur in one to three years in warmer mainstems or may take seven years in cold headwaters (Peven 1990; Mullan et al. 1992). The greatest proportion of steelhead spend two years in fresh water (Mullan et al. 1992; Busby et al. 1996). This extended period of freshwater residency places a heavy reliance by steelhead on freshwater habitat conditions. Smolts typically leave the Wenatchee River in March to early June (Peven et al. 1994). The timing of smolt migration is regularly indexed at Rock Island dam as part of a smolt monitoring program (Chapman et al. 1994b). This has been reported since 1990. Most majority of the composite (wild + hatchery) steelhead smolts pass Rock Island in May (Chapman 1994b). Upper Columbia River adults then spend one to three years in the ocean before returning to their natal streams (Mullen et al. 1992), with most spending one or two years in the ocean (WDFW et al. 1990).

Chapman (1986) estimated the historic run size of Columbia River steelhead entering the Columbia River ranged between 449,000 to 554,000. By the 1930's the portion of the run destined for the mid-Columbia River runs was virtually gone (Craig and Suomela 1941). Since 1933, with the advent of hatchery programs following the construction of Columbia River dams, adult steelhead returns at Rock Island Dam and later at Wells Dam, demonstrated a long-term upward trend (Chapman et al. 1994b). Between 1933 and 1959, adult steelhead counts at Rock Island dam averaged 2,600 to 3,700 fish (NMFS 2000a). In the 1960's and 1970's, the counts averaged 6,700 and 5,400, respectively. The counts generally increased in the 1980's to between about 7,000 and 32,000, with the average number of steelhead ascending Rock Island dam between 1980 and 1990 (inclusive) was 15,700 (Peven 1992), with peaks during the mid-1980's between 22,000 and 32,000 fish. However, between 1990 and 1998, the counts have declined to about 4,600 to 12,400 (average about 7,200; Chapman et al. 1994b; NMFS 2000a). Meanwhile, the natural spawning component of the run has declined over time. Peven (1992) reported that in 1987, hatchery steelhead made up 73% of the steelhead run entering the Columbia River. The major concern for this ESU is the clear failure of the natural component to replace themselves (MCMCP 1998).

Mullan et al. (1992) constructed spawner/recruitment curves that indicate that factors outside tributary subbasins (primarily mainstem passage mortalities) have significant impacts to wild steelhead. Hatchery practices in the past have also contributed to the stock declines, including the practice of planting catchable rainbow trout, which have caused an increase in the incidental catch of steelhead (Chapman et al. 1994a). Introductions of large numbers of rainbow trout into the upper Columbia River watershed streams, designed to supplement a popular stream trout fishery, were common in the 1920's and 1930's and continued up until several years ago. Stocking of rainbow/steelhead trout smolts in the Wenatchee subbasin to mitigate dam passage related mortalities to this species, still continues. Planted steelhead juveniles compete

with wild fish for limited resources, especially while in natal tributaries. Steelhead plantings have also been documented to induce a “pied piper” effect on wild juveniles, leading them to move downstream, possibly prematurely. For returning adults, hybridization of native stocks with hatchery stocks represents a potential loss of biodiversity at the genetic level. To minimize these impacts, steelhead fish plantings used today are designed to supplement the outgoing smolt population and timed to coincide with the outmigration so as to minimize the competition for resources in the tributaries.

# SALMONID HABITAT CONDITIONS BY WATERSHED

## Introduction

This report discusses salmonid habitat conditions in terms of habitat factors that are limiting salmon, steelhead and bull trout production within the seven watersheds of the Wenatchee subbasin (WRIA 45) and the Squilchuck, Stemilt, and Colockum watersheds in WRIA 40, all contained within the boundaries of Chelan County (Figure 1). The watersheds of WRIA 45 are; Mainstem Wenatchee River, Mission Creek, Peshastin Creek, Icicle Creek, Chiwawa River, Nason Creek, and the White/Little Wenatchee River. The watershed boundaries are consistent with the USFS Hydrologic Unit Code (HUC) 5<sup>th</sup> field boundaries as they existed in the spring of 2001.

Habitat limiting factors are defined in the Salmon Recovery Act (RCW 77.85) as “conditions that limit the ability of the habitat to fully sustain populations of salmon.” Relying on the combined technical expertise of the TAC, fifteen habitat attributes were selected by the TAC as those habitat factors most likely to be limiting salmonid productivity in the Wenatchee subbasin watersheds and the WRIA 40 watersheds covered in this report. Habitat attributes are those environmental conditions that traditionally appear in the literature to describe the relationship between biological performance and the environment (Mobrand Biometrics 1999). The 16 habitat attributes evaluated are; 1) artificial obstructions, 2) screens and diversion, 3) riparian condition, 4) streambank condition, 5) floodplain connectivity, 6) width/depth ratio, 7) entrenchment ratio, 8) channel substrate, 9) large woody debris, 10) pool frequency, 11) pool depth, 12) off-channel habitat, 13) water temperature, 14) fine sediment, 15) dewatering, and 16) change in flow regime. The habitat attributes have been lumped into six categories according to the attributes’ relationship to its physical environment. The categories are: 1) Access to Spawning and Rearing Habitat; 2) Riparian Condition; 3) Channel Conditions/Dynamics; 4) Habitat Elements; 5) Water Quality; and 6) Water Quantity. Both the categories of habitat limiting factors and the habitat attributes were selected based on input from the TAC (Table 13).

A discussion of each habitat attribute is provided below in the section, “Categories of Habitat Limiting Factors”. The discussion provides some background on each of the categories of habitat limiting factors and the specific attributes. Reading through “Categories of Habitat Limiting Factors” will provide the reader with a sense of the interconnectedness of the habitat categories and how they relate to productivity of a species and particular life stages.

Within the section of this chapter titled, “Habitat Limiting Factors by Watershed”, the seven watersheds of WRIA 45 and three watersheds of WRIA 40, are presented in detail under the headings: Watershed Description; Watershed Discussion of Hydrogeomorphology and Habitat Conditions; Watershed Current Known Habitat Conditions; Watershed Fish Use and Distribution; Watershed Summary; Watershed Data

Gaps; and Watershed Project Recommendations. To facilitate the presentation of information for two of the WRIA 45 watersheds, the Mainstem Wenatchee River and the White/Little Wenatchee River, these watersheds are further broken up into drainages within their respective watershed sections, and then discussed in detail.

Finally a section titled, “Subbasin Summary” is provided at the end of this chapter. This section discusses the relative significance of all the watersheds within WRIA 45 and the three watersheds of WRIA 40 to maintaining salmonid performance in the Wenatchee subbasin.

The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

## **Description of Categories of Habitat Limiting Factors**

### **ACCESS TO SPAWNING AND REARING HABITAT.**

In general, spring spawning species (rainbow/steelhead) take advantage of high spring flows, accessing smaller tributaries, headwater streams and spring snowmelt-fed streams not accessible later in the year. Reproduction of late summer and fall-spawning species (spring chinook, summer chinook, and fluvial bull trout) occurs most frequently in alluvial reaches of larger streams and rivers where groundwater recharge strongly buffers local interstitial and surface water conditions from decreasing flows and increasing or decreasing water temperatures. Incubation of salmonid eggs and fry occurs within the interstitial spaces of gravels in the beds of cool, clean streams and rivers. Once emergence from the gravel is complete, young salmon are mobile, which increases their flexibility to cope with environmental variation by seeking suitable habitat conditions. Mobility is limited however, particularly for fry, so that suitable habitat and food resources must be available in proximity to spawning areas for successful first-year survival. Ideal rearing habitat affords low-velocity cover, a steady supply of small food particles, and refuge from larger predatory fishes, birds and mammals (Williams et al. 1996).

Salmon are limited to spawning and rearing locations by natural features of the landscape. These features include channel gradient and the presence of certain physical features of the landscape (e.g. logjams). Flow can affect the ability of some landscape features to function as barriers. For example, some falls may be impassable at low flows, but then become passable at higher flows. In some cases flows themselves can present a barrier such as when extreme low flows occur in some channels; at higher flows fish are not blocked.

Throughout Washington, barriers have been constructed that have restricted or prevented juvenile and adult fish from gaining access to formerly accessible spawning and rearing habitat. These barriers include dams and diversions with no passage facilities, culverts poorly installed or designed, and dikes that isolate floodplain off-channel habitat. Known steelhead occurrence upstream of barrier culverts can usually be attributed to the potential for certain individual adult steelhead which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years. Additional factors considered are low stream flow or temperature conditions that function as barriers during certain times of the year. This category includes dams, dikes, culverts, and other artificial structures or conditions that restrict access to spawning habitat for adult salmonids or rearing habitat for juveniles. Included are barriers created by irrigation diversion dams and inadequate screens that allow access to unsuitable areas that result in mortality to salmonids. In the case of diversion dams, fish passage may be blocked or maintenance of the dam may require repeated manipulation of the stream bed (i.e. “push-up” diversion dams).

In 2000, Chelan County contracted Harza/Bioanalysts to assess the extent to which culverts were acting as barriers to adult and juvenile fish migration in areas of Chelan County not under federal or state ownership. A report was prepared describing the methods used to collect the information. Harza/Bioanalysts developed a database and GIS map coverage of the results as part of the assessment. The information has been incorporated into this report. Due to funding and time constraints, to determine passability through culverts, Harza/Bioanalysts relied almost exclusively on the portion of the Level A analysis described in WDFW’s Fish Passage Barrier Assessment and Prioritization Manual (1998b), which assesses a culverts passability based on a “greater than” or “less than” 0.8 foot drop at the outlet of the culvert. If there was greater than a 0.8 foot drop at the outlet, the culvert (or other structure) was determined to be a barrier. The 0.8 foot threshold was established in WAC 220-110-070 Section 3(b)(ii) Table 1, based on the known swimming ability under certain conditions of an **adult trout** (>6 inches/150 mm). Inherent limitations in this methodology for determining fish passage are: 1) under the “right” conditions in some years, some individual adult steelhead trout which are strong swimmers may exceed the average ability and pass through an “impassable” culvert; 2) passage of juvenile salmonids and adult chinook are not considered using this methodology; 3) the 1998 version of the manual does not contain criteria for determining passability at diversion dams and concrete flumes; and 4) where additional analysis may be required to determine whether a culvert is a barrier according to the Level A analysis (i.e. a Level B analysis), funding for further analysis was not available.

The Chelan County Watershed Department took the culvert inventory data collected by Harza/Bioanalysts (2000) and added culvert and fish passage barrier data maintained by the USFS, DNR, SSHEAR, including miscellaneous data provided by NRCS on Chumstick Creek culverts. Due to limitations on time and funding, at the time of publication of this report in mid-November 2001, the County culvert database did not accurately reflect the most currently available status of all known fish passage barrier culverts in Chelan County. The information contained in the following “Habitat Limiting

Factors by Watershed” section of this report, therefore uses only the “known” fish passage barrier culverts from the County’s culvert database, available at the time of publication of this report. However, additionally this report contains fish passage barriers, other than the culverts identified in the County culvert database, that are known to exist in Chelan County. The additional information is provided by resource professionals working in the region.

### Artificial Obstructions.

Improperly placed or maintained culverts have the potential to:

- prevent access for salmonid fry and parr to off-channel overwinter refuges of ponds, wetlands and small creeks that are often dry during the summer;
- hinder or prevent passage of adult and juvenile fish due to high water velocity, insufficient water depth, elevated outlet, or debris accumulation;
- create flows of a greater velocity and/or a shallower depth than that in the natural stream, often resulting in conditions that restrict or prevent the upstream movement of fish;
- cause the erosion and downcutting of the stream due to the relatively high velocity of water exiting the downstream end of a culvert which can also result in the formation of a vertical drop that may prevent fish from accessing the lower end of the culvert.

Improperly placed or maintained dikes, dams and other artificial structures can:

- block access to salmonid rearing habitat;
- block access to a portion of the floodplain;
- prevents further development of the side channel;
- prevents the recruitment of large woody debris;
- limits spawning gravel recruitment;
- confines the channel, concentrating flows within the mainstem, increasing the erosive nature of the flows. Bed scour within the reach can negatively impact salmonid redds.

Low flows, dewatering, and high/low instream temperature can:

- prevent upstream or downstream movement of adults and juveniles;
- contributes to stranding of juvenile salmonids.

#### Screens and Diversions.

Irrigation diversions, diversion dams, and screens can:

- allow fish to voluntarily or involuntarily move from the parent water body into the surface diversion leading to direct mortality from stranding when water diversions cease (diversion entrainment);
- create fish passage barriers during periods of low flow;
- allow fish to voluntarily or involuntarily move through, under or around the fish screen resulting in loss of fish from the population. This is a function of screen mesh opening size and gaps between the screen frame and canal structure walls (screen entrainment);
- may cause fish to involuntarily come in contact with and be entrapped by the screen surface due to approach velocities exceeding swimming capabilities resulting in direct mortality (impingement);
- maintenance of diversions can require repeated entry into stream channels disturbing spawning gravels and temporarily increasing sediment levels.

#### RIPARIAN CONDITION.

The riparian ecosystem is a bridge between upland habitats and the aquatic environment and includes the land adjacent to streams that interacts with the aquatic environment. Riparian forest characteristics in ecologically healthy watersheds are strongly influenced by climate, channel geomorphology, and location of the channel in the drainage network. For example, fires, severe windstorms, and debris flows can dramatically alter riparian characteristics. The width of the riparian zone and the extent of the riparian zone's influence on the stream are strongly related to stream size and drainage basin morphology. In a basin unimpacted by humans, the riparian zone would exist as a mosaic of tree stands of different acreage, ages (e.g. sizes), and species.

Riparian habitats include side channels which offer refuge from adverse winter conditions such as rain-on-snow events/flooding and icing, and often influence the water quality of adjacent aquatic systems. Riparian vegetation provides shade which shields

the water from direct solar radiation thereby moderating extreme temperature fluctuations during summer and keeping streams from freezing during winter. Riparian vegetation helps stabilize banks by maintaining masses of living roots which reduce surface erosion, mass wasting of stream banks and consequently reducing sediment delivered to the stream channel (Platts 1991). Riparian vegetation also contributes to the recruitment of large woody debris (LWD). Large woody debris contributes to channel complexity, including pool development, and sediment storage. Riparian ecosystems act as reservoirs, storing run-off in soil spaces and wetland areas and diminishing erosive forces caused by high flow events. The presence of stream-side vegetation also reduces pollutants, such as phosphorous and nitrates through filtration and binding them to the soil. Riparian vegetation contributes nutrients to the stream channel from leaf litter and terrestrial insects which fall into the water.

Riparian zones are impacted by all types of land use practices. Riparian forests can be completely removed, broken longitudinally by roads, and their widths can be reduced by land use practices. Further, species composition can be dramatically altered when native, old-growth, coniferous trees are harvested, allowing for the establishment of a younger seral stage of hardwood, deciduous tree species and young, smaller diameter conifers. Deciduous trees are typically of smaller diameter and shorter lived than coniferous species. They decompose faster than conifers so they do not persist as long in streams and are vulnerable to washing out from lower magnitude floods. Once impacted, the recovery of a riparian zone can take many decades as the forest cover reestablishes and matures and coniferous species colonize. In the more arid, narrower riparian zones common in the steep canyons of the lower Wenatchee subbasin watersheds, reestablishing conditions that support the regrowth of native riparian vegetation can be an even more difficult once the soil is disturbed.

Salmonids habitat requirements are met in part by healthy, functioning riparian habitat. For example: adequate stream flows must be present in order for fish to access and use pools and hiding cover provided by root wads and LWD positioned at the periphery of the stream channel. Microclimate, soil hydration, and groundwater influence stream flow; these factors are in turn influenced by riparian and upland vegetation. Vegetation and the humus layer intercept rainfall and surface flows. This moisture is later released in the form of humidity and gradual, metered outflow through groundwater where the geology supports the groundwater/surface water interaction. Through this process, stream flows may be maintained through periods of drought (Knutson and Naef 1997).

This category addresses factors that limit the ability of native riparian vegetation to provide shade, nutrients, bank stability, and a source for LWD. Human impacts to riparian function include timber harvest, clearing for agriculture or development, construction of roads, dikes, or other structures, and direct access of livestock to stream channels.

Some types of timber harvest (i.e. poorly managed riparian harvests and riparian clearcuts) or clearing for agriculture or development in riparian areas can:

- decrease bank stability;
- decrease LWD recruitment;
- result in a loss of shading;
- result in a loss of cold water refugia;
- increase sediment recruitment;
- decrease sources for nutrient input.

Improperly constructed roads, dikes or other structures can:

- interfere with delivery of LWD to stream channels;
- constrain lateral channel migration;
- increase sediment delivery to stream channels;
- increase surface water runoff to stream channels;
- contribute to increases in bank instability;
- contribute to channel downcutting.

Poorly managed livestock grazing can:

- decrease bank stability;
- increase sediment recruitment;
- alter the composition of riparian vegetation;
- compact soil.

#### CHANNEL CONDITIONS/DYNAMICS.

A stream channel represents the integration of physical processes occurring at the watershed level: hydrologic (i.e. precipitation, snow melt); erosional (i.e. debris flows, mass wasting); and tectonic processes (i.e. folded strata may dictate valley location, or rivers may exploit bedrock weakness along fault systems). The physical processes determine sediment, water, and LWD input to the channel. At the same time channel form or morphology is naturally constrained both laterally and vertically by valley form, riparian conditions and geology. The ability of the channel to transport and manage sediment, water and LWD is a function of the channel's morphology and roughness and the input of sediment and LWD (i.e. source, transport or response reaches; Montgomery

and Buffington 1993). Channel form will change when any of these inputs are altered or when the channel is artificially confined or constrained.

Riprap constructed to reduce a river's ability to migrate laterally and to reduce overbank flows within the channel migration zone, can retard habitat-forming processes and disrupt the bedload and LWD transport regimes of the river system. Additionally, improperly placed riprap can contribute to localized bed scour or channel incision, reducing the stream's ability to access its floodplain (USFS 1999c). Riprap can also lead to accelerated bank erosion by diverting flow energies to more vulnerable stream banks in the reach; where riprap contributes to stream incision, the toes of banks in the incised or bedscoured reaches are weakened and can fail.

Human land use activities within a watershed (i.e. road development, vegetation removal, water diversion) can alter the outcome of physical processes on channel formation and alter the ability of the channel to develop both laterally and vertically. For example, the quality and quantity of salmonid rearing and spawning habitat in a stream channel is controlled by the interaction of sediment and LWD with water and the transport of all three components through the channel network. Altering LWD levels or increasing sediment input can result in a decrease in the number and quality of pools, a decrease in the ability of the channel to retain sediment and organic matter, and an increasing width to depth ratio in low gradient reaches. Confining or constricting the stream channel can affect the rate and manner of sediment, LWD, and water transport through the system. It is important to note that habitat conditions in fish-bearing streams are intimately influenced by contributions of sediment and LWD from non-fish-bearing streams within a watershed. In the Pacific Northwest, LWD has been found to have a significant influence on the formation of pools and channel form (Nelson 1998).

Roads can affect streams directly by accelerating erosion and sediment loading, by altering channel morphology, and by changing the runoff characteristics of watersheds. These changes can later affect physical processes in streams, leading to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition and stability of slopes adjacent to streams (Furniss et al. 1991). Sediment entering stream is delivered chiefly by mass soil movements and surface erosion processes (Swanston 1991). Failure of stream crossings, diversion of streams by roads, washout of road fills, and accelerated scour at culvert outlets are also important sources of sedimentation in streams within roaded watersheds (Furniss et al. 1991).

Improper agricultural practices and residential/urban development can also affect streams by accelerating erosion and sediment loading to streams and by changing the runoff characteristics of watersheds. Farmed fields left fallow (i.e. barren of vegetative cover) cause much surface erosion and sediment movement to streams as winter snow melts and runs off carrying soil into stream channels. This is particularly a problem where riparian vegetation has been removed and the land is farmed up to the bank's edge. The conversion of riparian habitat to landscaped lawns has the same effect, removing bank

stabilizing root mass thereby contributing to accelerated streambank erosion. Riparian vegetation naturally functions as a filter, capturing sediments and buffering the flow of surface runoff into stream channels.

This category addresses impacts to the channel's physical form and function resulting from land use management practices that degrade the riparian zone or confine or constrain the stream channel.

#### Streambank Condition.

Natural stream channel stability is achieved by allowing the river to develop a stable dimension, pattern, and profile such that over time, channel features are maintained and the stream system neither aggrades or degrades (Leopold et al. 1992, Rosgen 1996). For a stream to be stable it must be able to consistently transport its sediment load, both size and type (Leopold et al. 1992, Rosgen 1996). When the stream laterally migrates, but maintains its bankfull width and width/depth ratio, stability is achieved even though the river is considered to be an "active" and "dynamic" system (Rosgen 1996). Changes in discharge and sediment supply result in a limited number of possible channel adjustments, which vary with channel form and position within the stream network (Montgomery and Buffington 1993). Potential adjustments include changes in width, depth, velocity, slope, roughness and sediment size (Leopold et al. 1992). Channel instability occurs when, over a period of years, the scouring process leads to degradation (downcutting), or excessive sediment deposition results in aggradation. This attribute includes known areas of destabilized streambanks, actively eroding or stabilized by some channel stabilization technique.

#### Floodplain Connectivity.

Floodplains are relatively flat areas adjacent to larger streams and rivers that are periodically inundated during high flows. In a natural state, they allow for the development of productive aquatic habitats through lateral movement of the main channel. Floodplains also provide storage for floodwaters, sediment, and large woody debris. Floodplains generally contain numerous sloughs, side channels, and other features that provide important spawning habitat, rearing habitat, and refugia during high flows. Large woody debris in an active channel or floodplain creates conditions necessary for plant colonization within an alluvial plain. Large woody debris is a primary determinant of channel morphology, forming pools, creating low velocity zones, regulating the transport of sediment, gravel, organic matter and nutrients and providing habitat and cover for fish (Bisson et al. 1987). The alluvial fan area of a stream's floodplain is an important feature of the floodplain, dissipating flow energy and maintaining and creating suitable rearing and spawning habitat over a wide range of flows. However, along larger mainstem streams, where a tributary's alluvial fan encroaches on the mainstem's floodplain (for example, at the edge of a valley wall), fans can constrict flood flows of the mainstem and locally increase energies.

There are two major types of human impacts to floodplain functions. First, channels are disconnected from their floodplain laterally as a result of the construction of dikes and levees, which often occur simultaneously with the construction of roads, and longitudinally as a result of the construction of road crossings. Riparian forests are typically reduced or eliminated as levees and dikes are constructed. Channels can also become disconnected from their floodplains as a result of downcutting and incision (degrading) of the channel from losses of LWD, decreased sediment supplies, and increased high flow events. Reduced overbank flooding resulting from increased entrenchment can reduce groundwater recharge and alter the flow regime (Naiman et al. 1992).

The second major type of impact is loss of natural riparian and upland vegetation. Conversion of mature vegetated cover to impervious surfaces, early-mid seral deciduous riparian stands, pastures, and farmed fields has occurred as floodplains have been converted to urban/residential and agricultural uses. This has: 1) eliminated off-channel habitats such as sloughs and side channels, 2) increased flow velocity during flood events due to the constriction of the channel, 3) reduced subsurface flows, and 4) simplified channels since LWD is lost and channels are often straightened when levees are constructed.

Elimination of off-channel habitats can result in the loss of important rearing habitats for juvenile salmonids such as sloughs and backwaters that function as overwintering habitat for spring chinook, steelhead and bull trout. The loss of LWD from channels reduces the amount of rearing habitat available for juveniles. Disconnection of the stream channels from their floodplain due to levee and dike construction increases water velocities, which in turn increases scour of the streambed. Salmon that spawn in these areas may have reduced egg to fry survival due to the scour. Removal of riparian zones can increase stream temperatures in channels, which can stress both adult and juvenile salmon. Sufficiently high temperatures can increase mortality.

This attribute includes direct loss of aquatic habitat from human activities in floodplains (such as filling) and disconnection of main channels from floodplains with dikes, levees, and revetments. Disconnection can also result from channel degradation (downcutting) caused by changes in hydrology or sediment inputs.

#### Width/Depth Ratio.

The width/depth ratio is defined as the ratio of the bankfull surface width to the mean depth of the bankfull channel (MacDonald et al. 1991; Rosgen 1996; Bain and Stevenson 1999). The bankfull stage is associated with the flow that just fills the channel to the top of its banks and at a point where the water begins to overflow into a floodplain (MacDonald et al. 1991; Rosgen 1996). Width/depth ratio is the most sensitive and positive indicator of trends in channel instability due to channel aggradation of any morphological characteristic (Rosgen 1996).

The magnitude and rate of change in channel width and width/depth ratio will depend on factors such as the slope of the stream the shape of the valley bottom, the bank and bed materials, and the recent flood history. Stream channel measurements must be combined with information on management activities, storm events, and sediment sources (i.e. roads, debris flows, landslides, or fires). Although this may make it difficult to establish specific standards, it should not mask general trends.

Natural stream channel stability is achieved by allowing the river to develop a stable dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades or degrades. For a stream to be stable it must be able to consistently transport its sediment load, both in size and type, associated with local deposition and scour (Rosgen 1996). Channel instability can occur when the amount sediment entering the system exceeds the channel's transport capacity and deposition results in aggradation. As the width/depth ratio increases, (i.e. the channel grows wider and more shallow), the hydraulic stress against the bank also increases and bank erosion is accelerated. Increases in the sediment supply to the channel develop from bank erosion, which by virtue of becoming an over widened channel, gradually loses its capability to transport sediment. Deposition occurs, further accelerating bank erosion, and the cycle continues (Rosgen 1996). A stream reach with eroding banks should be evaluated to determine to what extent the bank instability is within the natural range of variability or is a symptom of an increased trend toward channel degradation (incision) or aggradation (widening) resulting from human-induced changes to the watershed.

This attribute addresses conditions where there is a trend toward channel aggradation.

#### Entrenchment Ratio.

Entrenchment describes the relationship of the river to its valley and landform features in terms of the vertical containment of the river (Rosgen 1996). The entrenchment ratio is defined as the ratio of the flood-prone area width to the bankfull channel width. The flood-prone area width is measured at the elevation that corresponds to twice the maximum depth of the bankfull channel as taken from the established bankfull stage (Rosgen 1996). Entrenchment is qualitatively defined as the vertical containment of a river and the degree to which it is incised in the valley floor (Rosgen 1996).

The magnitude and rate of change in channel depth and width/depth ratio will depend on factors such as the slope of the stream the shape of the valley bottom, the bank and bed materials, and the recent flood history. Stream channel measurements must be combined with information on management activities, storm events, and sediment sources (i.e. roads, debris flows, landslides, or fires). Although this may make it difficult to establish specific standards, it should not mask general trends.

Natural stream channel stability is achieved by allowing the river to develop a stable dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades or degrades. For a stream to be stable it must be able

to consistently transport its sediment load, both in size and type, associated with local deposition and scour. Channel instability may occur when the scouring process leads to degradation or lowering of the channel bed (Rosgen 1996). This may occur as a result of alterations within a watershed that increase stream discharge, increase stream gradient or decrease channel roughness features (i.e. Headcuts are evidence of a stream channel attempting to reestablish an equilibrium in slope by lowering its bed (Leopold et al. 1992). A stream with eroding banks or headcut activity should be evaluated to determine to what extent the channel instability is within the range of natural variability or is a symptom of an increased trend toward channel degradation (incision) or aggradation (widening) resulting from human-induced changes in the watershed.

This attribute addresses conditions where there is a trend toward channel degradation.

### HABITAT ELEMENTS.

This category includes components of the stream channel that contribute to habitat complexity. These elements in turn translate to an increased potential for density dependent salmonid productivity.

#### Channel Substrate

Substrate refers to the mineral and organic material forming the bottom of a waterway or waterbody. The composition of the substrate determines the roughness of stream channels, and roughness has a large influence on channel hydraulics (water depth, width, and current velocity) of stream habitat. Substrate provides the micro-conditions needed by salmonids for both spawning and rearing (Bjornn and Reiser 1991). During incubation, sufficient water must circulate through the redd as deep as the egg pocket to supply the embryos with oxygen and carry away waste products (Bjornn and Reiser 1991). Once incubation is complete and the alevins are ready to emerge from the redd and begin life in the stream, they must move from the egg pocket up through interstitial spaces to the surface of the streambed. If fine sediments are being transported in a stream, some of the sediment is likely to be deposited in the redd. Emergence can be a problem if the interstitial spaces have been filled with sediment and do not permit passage of the alevins (Bjornn and Reiser 1991). The amount of fine sediment deposited and the depth to which it intrudes depend on the size of substrate in the redd, flow conditions in the stream, and the amount and size of sediment being transported (Bjornn and Reiser 1991). Increased sediments also reduce pool depth from pool filling, alter substrate composition, and result, through channel aggradation, in streambank instability. This attribute includes substrate conditions as they relate to rearing habitat only, including but not limited to, the degree of substrate embeddedness and substrate mobility.

## Large Woody Debris (LWD).

LWD provides important physical and biological functions in the wide variety of habitats used by all salmonids; such as cover in which to hide from predators or retreat from high velocities. The presence of LWD in the floodplain creates the diversity of habitat conditions that support multiple life stages of salmonids. In small streams, LWD traps sediment, causes local bed and bank scour, and creates pools. Small channels are highly dependent on in-channel woody debris structure for stability. Nelson (1998) states that the abundance of LWD is often associated with the abundance of salmonids and is thought to be the most important structural component of salmon habitat. Large woody debris east of the Cascades is generally described as wood material (>12 in diameter and >35 ft long; USFWS 1998) that mainly enters stream channels from stream bank undercutting, windthrow, and slope failures.

When considering channel conditions in fish-bearing streams, the potential contribution or recruitment of LWD from non-fish-bearing tributaries is an important factor. Size standards for LWD and number of pieces per area are highly variable between agencies. So are the threshold criteria established to differentiate between levels of habitat functionality as it relates to LWD. Some of this variation is the result of the variability among stream geomorphology, hydrology and the surrounding ecosystem. The anticipated location and size of LWD accumulations within a stream channel and its floodplain are a function of the stream's hydrology, its physical characteristics (geomorphology) and the surrounding physical/vegetative environment. For example, the White/Little Wenatchee watershed analysis (USFS 1998m) showed that the White and Little Wenatchee river channels may be comparable to the Chiwawa River, Nason, and Icicle creeks channels in terms of processes and range of natural condition. The mainstem Chiwawa River (95-160 LWD>12"/mile) and Indian Creek, Reach 2 (74 LWD>12"/mile) may represent the natural condition of LWD abundance in low gradient, gravel-dominated, pool-riffle channels in this landtype (USFS 1998c).

LWD creates lateral channel migration and complexity. It sorts gravels, stores sediment and gravel, contributes to channel stabilization and energy dissipation and maintains floodplain connectivity. Large accumulations of LWD in the lower floodplain can direct flow into meander loops and result in formation of riverine ponds and other off-channel habitat features, providing for the recruitment of new LWD from these side channel areas. Large woody debris can also indirectly function as a formative factor in channel processes.

This attribute addresses impacts resulting from: the removal or the lack of LWD; and the decrease or the loss in LWD recruitment and/or recruitment potential.

Absence of large woody debris:

- decreases complexity with fewer pools and less off channel habitat;
- lowers productivity;

- decreases channel stabilization;
- decreases energy dissipation;
- decreases cover.

### Pool Frequency.

Pools are formed by the interaction of flow with solid and loose boundaries, such as LWD, boulders, bends, streambed and other flows (Nelson 1998). Pool formation primarily occurs during moderate to high flow events. The interaction of flow with these boundaries causes flow to converge and accelerate, increasing bed scour though increases in bed shear stress. Pools form around channel obstructions (i.e. boulders, bridge piers, culverts, LWD), at meander bends, and at tributary channel junctions (Nelson 1998). Sediment levels, LWD levels, and human-made channel obstructions can alter the pattern and frequency of pool development within the geologic and hydrologic confines of the channel. Pools function to provide adult holding habitat, juvenile overwinter rearing habitat and thermal refuge.

In a study of how sediment supply influences features like pools and habitat diversity in the presence of LWD, Nelson (1998) concluded that large woody debris had the most significant influence on pool frequency and amount of pool area present, with pool area is a function of LWD and channel slope. The location of LWD within the bankfull channel had a significant effect on the amount of pool area. Large woody debris in contact with the summer low flow stream channel was the most effective at forming pools. Large woody debris was also the primary pool-forming factor identified. No significant relationship was found between sediment supply and pool area although sediment supply did appear to have a weak positive relationship to pool frequency.

This attribute addresses pools identified as the percent of wetted channel surface area comprising pool habitat, based on channel type.

### Pool Depth.

In a study conducted in the Skagit and Stilliquamish watersheds (Nelson 1998), pool depth was determined to be predominantly a function of drainage area. Sediment supply by itself was not significantly related to pool depth, however, when sediment supply is combined with basin area these two variables explain significantly more of the variation in pool depth than either individually. Increases in sediment supply resulted in a slight decrease in pool depth and appear to take a subordinate role to basin area.

Pool depth is significant in that it affects the value of a pool for thermal refuge, adult holding, and juvenile overwintering habitat. Other variables, like shading provided by riparian vegetation and LWD structures associated with pools, can improve a pool's

usefulness to fish. This attribute evaluates the presence or absence of pools greater than three feet deep (1 meter) in stream greater than nine feet (3 meters) in wetted width.

#### Off-Channel Habitat.

Off-channel habitat, or side channels, are formed as a by-product of channel migration and woody debris input and sediment accumulations (USFS 1998m). Side channels are most predominant in stream types located in narrow to wide valleys and constructed from alluvial deposition (C type channel; Rosgen 1996; USFS 1998m). The “C” type channels also have a well developed floodplain (slightly entrenched), are relatively sinuous with a channel slope of 2% or less and a bedform morphology indicative of a riffle/pool configuration (Rosgen 1996). Off-channel habitat provides refuge for rearing juveniles from high flow events that can otherwise flush young fish downstream, potentially into less suitable habitat.

Juvenile salmonids are known to use the mouth of tributaries to known fish-bearing streams, to rear, generally not moving more than a few hundred feet to a ¼ mile up into the tributary. This is typically referred to as “pull-in” behavior. These areas tend to represent that portion of the tributary that functions as an alluvial fan and is influenced by the channel migration zone of the mainstem (TAC 2000). The “pull-in” areas along with side channels and oxbows of the mainstem or accessible sections of tributaries provide protection from larger, predatory fish, and protection from higher flows.

This attribute includes side channels, sloughs, and surface-connected wetlands that provide refuge from high velocity flows and predation for rearing juvenile salmonids.

#### WATER QUALITY.

Cool, well-oxygenated water is required by salmonids. As stream temperatures rise, their dissolved oxygen content is reduced. Water temperatures of approximately 23-25°C (73-77°F) are lethal to salmon and steelhead (Theurer et al. 1985) and genetic abnormalities or mortality of salmonid eggs occurs above 11°C (51.8°F).

Temperature increases and consequent reductions in available oxygen tend to have deleterious effects on fish and other organisms by: 1) inhibiting their growth and disrupting their metabolism; 2) amplifying the effects of toxic substance; 3) increasing susceptibility to diseases and pathogens; 4) encouraging an overgrowth of bacteria and algae which further consume available oxygen; and 5) creating thermal barrier to fish passage.

In addition to fine sediment levels and water temperatures, other water quality parameters such as dissolved oxygen (DO) levels, the presence of fecal coliform, and pH levels can affect salmonid habitat quality. Major potential stream pollutants include nutrients such

as nitrates and phosphates, heavy metals from mining waste, and compounds such as insecticides, herbicides, and industrial chemicals.

Water quality parameters addressed by this category include only stream temperature and fine sediment that directly affect salmonid production. Currently, these two water quality parameters are considered to be having a much greater negative influence on salmonid production in the Wenatchee subbasin than the other parameters (TAC 2000). Therefore, dissolved oxygen levels, fecal coliform, pH levels, nutrients, heavy metals and agricultural/industrial chemicals are not addressed in this category although exceedences of state/federal water quality standards for some of these parameters have been documented in areas of the Wenatchee subbasin, especially in Mission, Brender and Chumstick creeks (Hindes 1994). Dewatering/low flows, high summer instream temperatures, fish passage and loss of floodplain functions are of much greater concern regarding salmonid production in these streams.

### Temperature.

Water temperature strongly influences the composition of aquatic communities with salmonids thriving or surviving only within a limited temperature range. Physiological functions are commonly influenced by temperature, some behaviors are linked to temperature, and temperature is closely associated with many life cycle changes. Temperature indirectly influences oxygen solubility, nutrient availability, and the decomposition of organic matter; all of which affect the structure and function of biotic communities. As water warms, oxygen and nutrient availability decrease, whereas many physiological and material decomposition rates increase. These temperatures-moderated processes can influence the spatial and temporal distribution of fish species and aquatic organisms (Bain and Stevenson 1999).

Water temperature varies with time of day, season, and water depth. Although temperatures are particularly dependent on direct solar radiation, they are also influenced by water velocity, climate, elevation, location of stream in the watershed network, amount of streamside vegetation providing shade, water source, temperature and volume of groundwater input, the dimensions of the stream channel, and human impact. To effectively analyze the extent of impacts of high instream temperatures on salmonid behavior and survival, the duration of the high instream temperatures needs to be considered. For example, water temperatures may increase during the summer months during the daytime hours but may decrease in the evenings as the air temperature also drops. This diurnal effect on instream temperatures can act as a temporary barrier or stressor to salmonids. Conversely, instream temperatures that remain above preferred temperatures for salmonids for an extended period of time, may have more significant impacts to salmonid survivability and health. There are other factors that need to be considered when assessing the extent of short-term or more extended periods of high instream temperatures on salmonids (i.e. fish densities, habitat quality, habitat quantity, time of year). This attribute addresses high or low instream water temperatures that negatively affect salmonid migration or survival during any life history stage.

### Fine Sediment.

This attribute addresses impacts to spawning habitat from fine sediment levels. Only data that is derived from McNeil core sampling will be considered except in unmanaged areas (wilderness) where fine sediment conditions were rated as “Good” (Properly Functioning) even if McNeil core sampling were not available. In unmanaged areas, fine sediment accumulations can be considered a naturally-occurring condition (TAC 2000).

Streambed particles in the redd after eggs have been laid and covered, and particles that settle into the redd and surrounding substrate during incubation, affect the rate of water interchange between the stream and the redd, the amount of oxygen available to the embryos, the concentration of embryo wastes, and the movement of alevins (especially when they are ready to emerge from the redd). Condition for embryos within redds may change little or greatly during incubation depending on weather, streamflows, spawning by other fish in the same area at a later time, and fine sediments and organic materials transported in the stream. Redds that remain intact during incubation may become less suitable for embryos if fine sediments are deposited in the interstitial spaces between the larger particles. The fine inorganic particles impede the movement of water and alevins in the redd and fine organic particles consume oxygen during decomposition; if the oxygen is consumed faster than the reduced intragravel water flow can replace it, the embryos or alevins will asphyxiate (Bjornn and Reiser 1991).

### WATER QUANTITY.

Changes in flow conditions can have a variety of effects on salmonid habitat. Decreased flows can reduce the availability of summer rearing habitat and contribute to temperature and access problems, while increased peak flows can scour or fill spawning redds. Other alterations to seasonal hydrology can strand fish or limit the availability of habitat at various life stages. Extended periods of low flows can delay the movement of adults into streams, draining their limited energy reserves, affecting upstream distribution and spawning success. High winter flows can cause egg mortalities by scouring and/or sedimentation of the spawning beds. Low winter flows can contribute to anchor ice formation and result in the freezing of eggs or stranding of fry. The overwinter survival of juvenile fish can be negatively affected by the reduction in the quantity and quality of winter rearing habitat as a result of low flows.

Stream flow is moderated by riparian vegetation as well as vegetative cover in the uplands. The removal of upland and riparian vegetation through timber harvest, road development, and through the conversion of land for agriculture and residential/urban use alters surface water runoff patterns and ground water storage patterns. There is some debate concerning the extent to which upland vegetation affects stream flow regimes when analyzed at certain scales. Based on the relative area of upland to riparian habitat, there is discussion that in terms of precipitation interception, and evapotranspiration, uplands may play a bigger role than previously considered. Regarding riparian areas, riparian vegetation assists in regulating stream flow by intercepting rainfall, contributing

to water infiltration, and using water via evapotranspiration. Plant roots increase soil permeability, and vegetation helps to trap water flowing on the surface, thereby aiding infiltration. Water stored in the subsurface sediments is later released to streams through subsurface flows. Through these processes, riparian and upland vegetation help to moderate storm-related flows and reduce the magnitude of peak flows and the frequency of flooding.

Stream flows are also be affected by the removal of instream flows for domestic, agricultural and municipal use, thereby reducing fish habitat quantity and quality. The impacts of reduced flows vary depending on a combination of fish use in the affected reach and the extent and duration of reduced flows.

This category addresses changes in flow conditions brought about by changes in upland vegetative cover, road development, and water diversions.

Changes in upland vegetative cover can:

- influences snow accumulation and melt rates;
- influences evapotranspiration and soil water content;
- influences soil structure affecting infiltration and water transmission rates.

Road development can:

- increase magnitude and advance the timing of peak flow events by increasing impervious areas.

Water diversions can:

- delay or prevent movement of spawning/migrating adults and rearing juveniles;
- reduce available rearing areas for juveniles;
- contribute to increased water temperatures and decreased dissolved oxygen;
- dewater or contribute to low flow conditions downstream of the point of diversion.

Dewatering.

Loss of flow in a channel or a stream reach can be the result of natural hydro-geologic conditions, the result of human activities, or a combination of both factors. Often the cause or causes of dewatering, when there have been significant alterations in the drainage, is difficult to determine. This attribute addresses those stream reaches where dewatering is known to occur downstream of a water diversion, when flows are still present upstream of the diversion, indicating a strong correlation between water diversion and loss of instream flow.

### Change in Flow Regime.

The quantity of available water and the rate at which it reaches the stream channel and passes through the channel system are influenced by precipitation regimes, watershed size, vegetation cover, and certain topographic consideration (Swanston 1991). Altering the vegetative component of a watershed and diverting instream flows for out-of-stream uses can have a significant effect on the timing and magnitude of peak and low flows. Changes in flow conditions can have a variety of effects on salmonid habitat. Decreased low flows can reduce the availability of summer rearing habitat and contribute to temperature and access problems, while increased peak flows can scour or bury spawning nests. Changes in percent cover, species composition, and/or stand age class can change interception, evapotranspiration and soil water retention rates thereby changing flow regimes. Timber harvest activities, conversion of land to agricultural and urban/residential use, and fire are all actions that have the potential to disturb the vegetative community of a drainage to the extent that there is a noticeable affect on the stream flow regime. High road densities, soil compaction associated with agricultural activities, timber harvest, and grazing all contribute to increased surface water runoff and decrease soil permeability and water retention. The diversion of instream flows have the potential to alter the magnitude and duration of low flows, affecting stream channel conditions and decreasing total wetted area.

This attribute addresses changes in peak or base flows and/or flow timing relative to what one would expect to see in an undisturbed watershed of similar size, geology and geography.

### **Habitat Limiting Factors by Watershed**

#### MAINSTEM WENATCHEE RIVER WATERSHED

##### *Mainstem Wenatchee River Watershed Description*

The Mainstem Wenatchee River Watershed covers the mainstem Wenatchee River, flowing southwesterly from its origination at the mouth of Lake Wenatchee (RM 54.2), to its junction with the Columbia River at the city of Wenatchee (Columbia River RM 468.4). It includes Derby Canyon (RM 19.0), Chumstick Creek (RM 23.5), Chiwaukum Creek (RM 36.0), and Beaver Creek (RM 46.5 ) drainages and the smaller tributaries flowing directly into the Wenatchee River between Lake Wenatchee and its confluence with the Columbia River. Excluded are the White/Little Wenatchee (which includes Lake Wenatchee), Chiwawa, Nason, Icicle, Peshastin, and Mission watersheds, which are covered as separate watersheds in this report. Watershed boundaries within Watershed Resource Inventory Area (WRIA) 45, the Wenatchee subbasin, are based on USFS Hydrologic Unit Code (HUC) 5<sup>th</sup> field levels as provided by the USFS in 2000. To allow for the presentation of information on the Wenatchee River and other fish-bearing drainages within the Mainstem Wenatchee River Watershed in adequate detail, the Wenatchee River, Derby Canyon, Chumstick, Chiwaukum, and Beaver Creek drainages are discussed separately within this Mainstem Wenatchee River Watershed section,

following an overall description of the Mainstem Wenatchee River watershed and general fish use within the watershed.

The Mainstem Wenatchee watershed encompasses approximately 203,088 acres (C. Raekes, USFS, pers. comm., 2001). Most of the annual stream flow in the Wenatchee River at the mouth originates from separate watersheds in the upper subbasin; the Chiwawa River (15%), the White River (25%), the Little Wenatchee River (15%), Nason Creek (18%), and Icicle Creek (20%). Snow melt in the Cascades is the principal source of water for the watershed's larger streams and provides about 80% of the total runoff from the watershed (USFS 1999a). Elevations range from 653 feet at the mouth to 7993 feet on Snowgrass Mountain in the Chiwaukum drainage of the Mainstem Wenatchee watershed. Precipitation varies from just over 8.5 inches per year in the town of Wenatchee (USFS 1999a), to upwards of 50 inches per year on both the Entiat and Tumwater Ridges in the Chumstick drainage (USFS 1999b). Approximately 18% of the watershed is in private ownership (36,923 acres), 3% state ownership (5,699 acres), 1% Public Utility District ownership (112 acres), and 60% USFS ownership. With the available existing GIS land ownership data within the national forest boundary, it was not possible for the USFS to determine ownership for 19 % of the total acreage of the watershed (38,952 acres; C. Raekes, USFS, pers. comm., 2001).

The Wenatchee River is paralleled by state highways for most of its length: State Highway 2 parallels the Wenatchee River from its mouth upstream to Tumwater Canyon; a County Road (River Road) parallels segments of the River between Tumwater Canyon and the community of Plain; State Highway 209 (Beaver Valley Highway) parallels the Wenatchee River on the west side from approximate RM 46.0 - 50.0, while County Road 22 parallels the east side of the river for the same approximate river miles. The towns of Wenatchee (RM 0.0), Cashmere (RM 10.4 ), Peshastin (RM 17.9 ), Leavenworth (RM 25.0), and Plain (RM 46.2) are sited along the Wenatchee River.

The primary natural disturbance processes in the watershed are fire and debris slides. Disturbances in ecosystems are important mechanisms of succession which provide for diversity on the landscape. In addition, native species have adapted to, and in part evolved with, natural disturbance events (USFS 1999c). The natural fire regime is a low intensity fire every 5-10 years in the lower elevations while the upper elevations have high intensity stand replacing fires every 50-100 years. Mass wasting are common after high intensity fires. Mass wasting also occur along the steep slopes in the weaker incompetent beds usually associated with shale (USFS 1999a).

Table 3 below, describes current, known salmon, steelhead, and bull trout use in the Mainstem Wenatchee River watershed. Summer chinook, spring chinook, bull trout and steelhead/rainbow trout both spawn and rear in waters within the Mainstem Wenatchee River Watershed. Sockeye rear but do not spawn within the watershed boundaries. All the salmonid species identified here rely on the Wenatchee River, which falls within the Mainstem Wenatchee Watershed, as a corridor to spawning and rearing habitat throughout the Wenatchee River subbasin (WRIA 45). Maps in Appendix A illustrate

salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 3: Current, known salmon, steelhead, and bull trout use in the Mainstem Wenatchee River watershed.**

Mainstem Wenatchee River Watershed	Spring Chinook			Summer Chinook			Steelhead/ Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Lower Wenatchee River (RM 0.0 – 25.6)		X	X	X	X	X	X	X	X			X		X	X
Middle Wenatchee River (RM 25.6 – 35.6)		X	X	X	X	X	X	X	X			X		X	X
Upper Wenatchee River (35.6 – 54.2)	X	X	X	X	X	X	X	X	X			X		X	X
Derby Canyon Creek							X	X							
Chumstick Creek		X					X	X	X						
Eagle Creek							X	X							
Chiwaukum Creek	X	X	X				X	X	X				X	X	X
Skinney Creek		X					X	X							
Beaver Creek							X	X							

**Wenatchee River.**

Wenatchee River Description. The elevation is 1,876 feet at the mouth of Lake Wenatchee where the Wenatchee River originates; the elevation at its confluence with the Columbia River is 615 feet. The valley bottom is entirely in private ownership from the mouth upstream to RM 27.0 just upstream of the Icicle Creek Road/Hwy. 2 junction. Upstream of RM 27.0, the Wenatchee River flows through a checkerboard pattern of private and federal ownership. The glacial till component of the valley bottom (in the upper watershed, above Tumwater Canyon) contributes greatly to the formation of wetlands and is linked to groundwater storage and remnant channel locations, and the most species richness in the entire watershed. Subsurface flow through the landtype is

relatively high, with subsurface and instream flow in continuity adjacent to streams (USFS 1999c).

With the 1890 construction of the Great Northern Railway up the Wenatchee River, came white settlement which included agriculture and irrigation diversions. Dryden Dam (RM 17.0), an 8-foot high irrigation diversion dam, was constructed along with the Highline Canal in the early 1900's (Hindes 1994) to provide for the water supply to the Wenatchee Reclamation District (up to 200 cfs; MCHCP 1998b). The Jones-Shotwell water diversion is located at RM 7.2. The Pioneer-Gunn water diversion, which began taking water in 1891 (Hindes 1994), is located at RM 6.6. Minimum flows were established by WAC 173.545.030 for the Wenatchee River at Monitor (RM 7.0), Peshastin (RM 21.5), and Plain (RM 46.2; Hindes 1994).

Because different geologic processes dominate the generation, transport, and storage of sediment and wood, the Wenatchee River, for the purposes of this report, is divided into three geologically distinct areas: 1) Upper Wenatchee, 2) Middle Wenatchee, and 3) Lower Wenatchee. This allows for the identification of channel networks which are comparable based on geologic, hydrologic and erosional processes which in turn, impose similar controls on channel processes (USFS 1999c).

- *Lower Wenatchee*: from the Columbia River confluence (RM 0.0) upstream to the bottom of Tumwater Canyon at Icicle Creek (RM 25.6); is divided into three reaches for the assessment portion of this report.
- *Middle Wenatchee*: Tumwater Canyon (RM 35.6 – 25.6); is presented as a single reach for the assessment portion of this report.
- *Upper Wenatchee*: from the top of Tumwater Canyon (RM 35.6) to the outlet of Lake Wenatchee (RM 54.2); is presented as a single reach for the assessment portion of this report.

#### Wenatchee River Discussion of Hydrogeomorphology and Habitat Conditions.

##### ***Lower Wenatchee (RM 0.0 - 25.6).***

In the Lower Wenatchee, the river flows through a floodplain formed by glacial meltwaters and subsequent over-bank floods. Included in the floodplain are alluvial fans and terraces that are elevated by stream downcutting. The major geomorphic processes have been mass wasting and fluvial downcutting through the underlying sedimentary rocks (USFS 1999c), which control the shape of the river and the surrounding area (USFS 1999c).

Forest service ownership occurs in the upper elevations in this portion of the Mainstem Wenatchee River Watershed. The Wenatchee River and the lower portions of its

tributaries are privately-owned there are development impacts along the entire valley bottom (orchards, housing ranging from scattered rural houses to towns, roads, powerlines and railroads). The history of settlement and on-going development has reduced instream LWD and LWD recruitment, and reduced side channel/wetland habitat and the opportunity for development of side channel/wetland habitat. The altered riparian and channel conditions have also: reduced pool frequency; increased bank erosion; possibly increased channel entrenchment in stream reaches not naturally confined by glacio-fluvial terraces; altered the sediment transport regime; and altered the natural flow regime (USFS 1999c). Stream diversions and well withdrawal from shallow aquifers in the floodplain probably have the greatest influence on low stream flows; channel confinement, channelization, and riparian and upland land use impacts probably have the greatest influence on peak flow timing and duration. However, actual identification and quantification of the causes and effects are complex and problematic.

The majority of the entrenchment in the Lower Wenatchee is a result of post-glacial downcutting through glacial fluvial deposits, however, where the river has been encroached upon by roads (State Hwy. 2) and development (i.e. the Cashmere and Monitor Flats area), this may have contributed to localized channel entrenchment. Overall, it is not believed that human land-use impacts have been the major influence in downcutting of the channel in the Lower Wenatchee River (M. Karrer and D. Driscoll, USFS, pers. comm., 2001). Likewise, although bank erosion has been exacerbated by land-use activities in some reaches of the Lower Wenatchee River, increased sediment loading from eroding banks is not thought to be significant at the Lower Wenatchee River level by some scientists (D. Driscoll, USFS, pers. comm., 2001). However, considering the extent of shoreline habitat impacts (31% entirely cleared of riparian vegetation; M. Miles, M. Miles and Associates, pers. comm., 2001), the amount of fine sediment observed in some gravels, (20%; D. Rife, USFS, pers. comm., 2000), and the long sections of high, eroding banks which may warrant further investigation to determine if there are localized impacts to salmonid habitat immediately downstream from sediment deposition, more survey data and analysis would allow scientists to determine the effects of sedimentation from bank erosion with more accuracy. In the summer of 2001, using state salmon recovery funds, a consultant was hired by Chelan County to initiate a channel migration zone study of the Lower Wenatchee River (RM 0.0 – 25.6). The study should allow for a more precise identification of functioning and non-functioning stream reaches. It will also assist in identifying some cause and effect conditions in the Lower Wenatchee River.

The Wenatchee River immediately downstream of Tumwater Canyon (RM 25.6) is evolved from glaciation in the Icicle River Drainage. An impoundment from a moraine (just north of the USFWS hatchery compound) filled and widened the valley with glacial till; a sinuous, unconfined, pool-riffle channel evolved as the river eroded through the glacial till. Today, overbank flows and lateral migration are channel processes that continue to shape the river valley. However, with development in the floodplain, flood control and channel control measures have been implemented (primarily riprap). As a result, off-channel habitats are severely lacking from RM 0.0 to Icicle Creek (RM 25.6; USFS 1999c). Additionally, these actions reduce the river's ability to dissipate energy through lateral migration. This can lead to downcutting of the channel bed and

accelerated bank erosion as high energy flows are contained within the channel. If the channel becomes too entrenched, it can lead to loss or “abandonment” of its natural floodplain.

The substrate of the mainstem Wenatchee River downstream of Derby Canyon (RM 19.0 - 0.0) is fairly uniform and rapids predominate. The channel is constrained naturally in a few places by alluvial fans. Scattered sandstone outcrops occur throughout the reach. These bedrock shelves are primarily pool-forming features. Rock Island Dam at RM 453.4 on the Columbia River (downstream of the mouth of the Wenatchee River), may at times impound water in the lower Wenatchee River. This has reduced the Wenatchee River’s capacity to transport fine sediment from the Wenatchee River. As a result, sediment has backed up the Wenatchee River creating a very level, uniform stream bottom and “quiet” surface water.

### ***Middle Wenatchee (RM 25.6 - 35.6).***

The Middle Wenatchee flows through Tumwater Canyon (RM 25.6 – 35.6), a higher gradient bedrock canyon with sections of large gravel beds where many of the Wenatchee River's summer chinook spawn. Hillslopes in the canyon are steep, where the Wenatchee River cuts through the resistant bedrock forming a deep, narrow, V-shaped valley. The stream channel is dominated by bedrock outcrops. Hatchery Creek, Fall Creek, Cabin Creek and Slide Creek are the only perennial tributaries entering this portion of the Wenatchee River (USFS 1999c). Large woody debris input occurs generally through slides. Although log jams can be relatively persistent in the canyon (M. Karrer, USFS, pers. comm., 2001), unincorporated material often does not remain intact in Tumwater Canyon, but is transported downstream during spring runoff flows.

Tumwater Canyon has a gradient of less than two percent (USFS 1999c), with long, deep pools alternating with cascading, rapids-type riffles. Flooding and debris flows are processes which shape the river in the canyon. Alluvial fans formed at the base of high gradient tributaries act as lateral and horizontal channel controls and deliver LWD and coarse sediment. During flood events, the material in the fans is eroded away by the river.

The river character through Tumwater Canyon has been modified over time due to railroad construction, dam construction, log drives, and highway construction and maintenance. During railroad construction in the late 1800’s, the canyon bottom was narrowed and large substrate removed. Consequently, high flow velocities were increased and LWD and coarse sediment input from the east canyon wall was reduced. Depending on very localized geologic conditions throughout the canyon, degradation processes may have begun. The construction of Tumwater Dam (RM 31.0) in the early 1900’s changed the character of the river upstream, creating 0.5 mile long Lake Jolanda. This impoundment has altered the sediment transport regime of the river, mainly storing coarse sediments above the dam while flushing fines sediments through. The depletion of these finer sized substrates below the dam has resulted in channel degradation. In the 1920’s the railroad was abandoned and State Highway 2 took its place, continuing to alter coarse sediment input from the east canyon wall. Finally, log drives started around the

turn of the century and continued until the 1930's. To facilitate the passage of logs through Tumwater Canyon, large boulders and log jams were blasted. Associated with this practice was splash damming (Baskette 1990). This activity probably resulted in a reduction in pools and an increase in steep, cascading rapid-type riffles. The overall result of the log drives is likely a reduction in pools, increase in gradient, increased bank erosion, increased channel entrenchment, and reduced LWD and boulder input (USFS 1999c).

***Upper Wenatchee (RM 35.6 - 54.2).***

In the Upper Wenatchee portion of the watershed, glaciation resulted in a thick mantle of till plastered on lower ridges and valley walls. Valley floors are covered with glaciofluvial outwash deposits. Primary disturbances are debris slides, seasonal flooding, and fire. All of these disturbances add woody debris to the stream channel. The upper river is meandering, only moderately confined, with an occasional adjacent wetland. The largest negative influence to habitat in the Upper Wenatchee (RM 35.6 – 54.2) is the location of the Beaver Valley Highway (State Hwy. 209), State Hwy. 207, and subsequent development of the area. Highway 209 cuts off a couple of old oxbows and limits floodplain use; the placement of Highway 207 as it crosses at the head of the river effectively acts as a dam during extreme high water events forcing all the flow down the main Wenatchee River channel (USFS 1999c).

From the mouth of Lake Wenatchee (RM 54.2) downstream to the Chiwawa River confluence (RM 48.4), the substrate is composed mainly of cobbles and gravels with relatively frequent large pools occurring mostly at riverbends. Approximately 585 acres of wetlands exist near the mouth of the lake down to Fish Lake Run (RM 53.0); old river oxbows and recent beaver dams exist throughout. This area is a glacial outwash plain where till from four tributary valleys was deposited. The till component in the wetlands can store a tremendous amount of near surface groundwater and can play a crucial role in maintaining higher, cooler baseflows (USFS 1999c). The river has subsequently cut through the glacial outwash over thousands of years, elevating the prehistoric alluvial floodplain and creating abandoned floodplain terraces. The river terraces naturally confine the channel somewhat and eroding banks are common in this environment, however sediment input is not exceeding channel transport capacity (USFS 1999c), indicating the reach is stable. Although not as significant an impact as in other reaches (B. Bugert, Governor's Salmon Recovery Office, pers. comm., 2001), LWD in this reach is low, possibly naturally limited by terraces but may also be related to historic log drives down the channel from 1903-1917, a management practice typically resulting in extreme habitat simplification (USFS 1999c).

From the Chiwawa River (RM 48.4) downstream to the top of Tumwater Canyon (RM 35.6), further downcutting of the channel bed has increased gradient, increasing entrenchment and reducing pool frequency. It is unclear from the literature whether this is a human-induced change. Larger substrates (cobble and boulders) exist in this higher gradient reach of the riverbed as smaller material from the glacial till deposits is washed

out of the substrate. Pools are typically located at meander beds and finer substrates occur in the pool tailouts. Large boulders do create some deep pocket pools. This reach of river has development along its entire length (rural pastoral lands, housing communities, roads, power lines and railroads). Improperly functioning septic systems, particularly in the vicinity of the communities of Plain and Ponderosa, contribute to degraded water quality (B. Bugert, Governor's Salmon Recovery Office, pers. comm., 2001). Bank hardening projects (riprap) to protect developed shorelines from erosion exacerbate the natural processes of streambank erosion and lateral channel migration in this reach and may elevate sediment production from the eroding streambank terraces (USFS 1999c). Large woody debris input (and potential pool habitat) is also reduced downstream of the Chiwawa River confluence in the Upper Wenatchee River by naturally elevated terraces, historic log drives (USFS 1999c), and floodplain/streamside development resulting in reduced riparian and wetland connectivity. (USFS 1999c).

Wenatchee River Current Known Habitat Conditions. The following list of information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### ***Lower Wenatchee (0.0 – 25.6)***

#### *Access to Spawning and Rearing*

##### Obstructions

(natural barriers are also provided here)

Lower Wenatchee River (45.0007). Dryden Dam (RM 17.0), an 8-foot high irrigation diversion dam, was constructed along with the Highline Canal to provide for the water supply to the Wenatchee Reclamation District. Dryden Dam currently has a fish ladder to facilitate passage The dam does not impede bedload transport and does not currently pose a migration delay to salmonids (C. Peven, Chelan County PUD, pers. comm., 2001).

##### Screens and Diversions

*NOTE:* Information on the location and condition of private water diversion are not available at this time. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Lower Wenatchee River. The Pioneer-Gunn water diversion is in compliance and located at RM 6.6 on the left bank. The Gunn ditch began taking water in 1891 (Hindes 1994).

Lower Wenatchee River. The Jones-Shotwell water diversion is in compliance and located at RM 7.2 on the right bank.

Lower Wenatchee River. The Pines Flat water diversion (Bryant and Parkhurst 1950) is located at about RM 10. No additional information is available.

Lower Wenatchee River. Dryden Dam (RM 17.0), an 8-foot high irrigation diversion dam, was constructed along with the Highline Canal in the early 1900's (Hindes 1994) to provide for the water supply to the Wenatchee Reclamation District (up to 200 cfs; MCHCP 1998b). The diversion is located on the left bank upstream of the town of Dryden. Dryden Dam currently has two fish ladders to facilitate passage. The dam does not impede bedload transport and does not currently pose a migration delay to salmonids (C. Peven, Chelan County PUD, pers. comm., 2001). The existing fish screen was constructed in 1992 to meet the design criteria in effect at that time. In the spring of 2001, the screen was updated by the Chelan County PUD and now meets current 2001 NMFS screening criteria.

### Riparian Condition

Lower Wenatchee River. Riparian road placement, riparian timber harvest, and the conversion of riparian areas to rural/residential/urban and agriculture uses has reduced instream LWD and LWD recruitment, and reduced side channel/wetland habitat and the opportunity for development of side channel/wetland habitat. The altered riparian and channel conditions have also: reduced pool frequency; increased bank erosion; possibly increased channel entrenchment in stream reaches not naturally confined by glacio-fluvial terraces; altered the sediment transport regime; and altered the natural flow regime (CRITFC 1995; USFS 1999c).

Lower Wenatchee River. In Spring 2001, Chelan County initiated a channel migration zone study of the Lower Wenatchee River (RM 0.0 – 25.6). The study will provide information on historic channel location and floodplain extent and estimate the volume of past riparian vegetation; determine current channel position, floodplain extent and the location/volume of remaining riparian vegetation; establish areas where future channel migration is likely to occur, and where the potential lies for reconnecting cut-off riparian areas and side-channels. Historic and current rates of channel migration will also be determined.

## Channel Conditions/Dynamics

### Streambank Condition

Lower Wenatchee River. Floodplain development has resulted in riparian habitat degradation over the majority of the Wenatchee River valley bottom. Additionally, flood control measures in reaches not naturally confined by glacio-fluvial terraces, and bank stabilization efforts to control lateral channel migration, have exacerbated bank erosion (CRITFC 1995; USFS 1999c).

In early 1996, the Chelan County PUD funded a very preliminary assessment of stream reach conditions on the mainstem Wenatchee River for the purpose of producing a presentation on the subject of channel conditions on the Wenatchee River. A 37-minute video was also produced which captured examples of channel dysfunction, relating them back to land use impacts along the channel migration zone of the Wenatchee River (Chelan County PUD 1997). Based on aerial photo interpretation accomplished during the assessment, the following numbers for bank characteristics were provided (M. Miles, M. Miles and Associates, pers. comm., 2001; Note: the numbers are for the entire length of the Wenatchee river, from RM 0.0- 54.2, where natural woody conditions are found primarily in the Upper Wenatchee and riprap conditions exists throughout the river's length with heavier concentrations in the lower watershed adjacent to the railroad tracks and Highway 2):

- 19% riprap;
- 16% natural woody;
- 31% entirely cleared;
- 35% narrow railroad.

In Spring 2001, Chelan County initiated a channel migration zone study of the Lower Wenatchee River (RM 0.0 – 25.6). The study will provide information on historic channel location and floodplain extent and estimate the volume of past riparian vegetation; determine current channel position, floodplain extent and the location/volume of remaining riparian vegetation; establish areas where future channel migration is likely to occur, and where the potential lies for reconnecting cut-off riparian areas and side-channels. Historic and current rates of channel migration will also be determined.

### Floodplain Connectivity

Lower Wenatchee River. Channelization of some tributaries to the Lower Wenatchee River and floodplain development along the Lower Wenatchee River corridor (municipal, orchards, homes, highway, railroad, powerlines) have degraded floodplain functions. Flood control measures in reaches not naturally confined by glacio-fluvial terraces (i.e. the vicinity of Monitor Flats and the town of Cashmere) have contributed to the loss of functioning floodplain habitat. The altered riparian and channel conditions have also:

reduced instream LWD and recruitment; reduced pool frequency; reduced side channel/wetland habitat and the opportunity for development of side channel/wetland habitat; increased bank erosion; possibly increased channel entrenchment in stream reaches not naturally confined by glacio-fluvial terraces; altered the sediment transport regime; and altered the natural flow regime (CRITFC 1995; USFS 1999c). Roads, railroads, orchards, and towns have likely had some of the largest impacts on the fishery resource on the mainstem Wenatchee River, limiting the use of alternate channels and access to the floodplain to disperse high flows (USFS 1999c; MCHCP 1998b).

Lower Wenatchee River. The towns of Monitor (RM 6.0) and Cashmere (RM 10.4) encroach upon the floodplain as do various orchards from the town of Leavenworth (RM 25.0) to the mouth of the river (USFS 1999c). Low-head berms were built in the 1950's near the communities of Monitor and Cashmere as flood protection (MCHCP 1998b) limiting the river's access to its floodplain (D. Ham, Northwest Hydraulic Consultants, Memorandum, June 18, 2001).

#### Width/Depth Ratio

Lower Wenatchee River. No identified concerns with increasing width/depth ratios provided in the literature or by professional knowledge.

#### Entrenchment Ratio

Lower Wenatchee River. The history of settlement and on-going development has altered the riparian and channel conditions resulting in: reduced instream LWD and recruitment; reduced pool frequency; reduced side channel/wetland habitat and the opportunity for development of side channel/wetland habitat; increased bank erosion; possibly increased channel entrenchment in stream reaches not naturally confined by glacio-fluvial terraces; altered the sediment transport regime; and altered the natural flow regime (CRITFC 1995; USFS 1999c).

Lower Wenatchee River. Preliminary aerial photo analysis using photos from 1956 – 1992, shows the Wenatchee River narrowed between the river mouth and the base of Tumwater Canyon. The narrowing may result from confinement by bank and flood protection works or from channel incision, although a quick review of gauge records for the Wenatchee River at the Peshastin gauge shows no obvious trend towards bed lowering over the period of record (1929 – 1999). Analysis of aerial photos from 1992 – 2001 may reveal different behavior. Also, it seems that entrenchment may be less significant in explaining the observed changes in channel width up to 1992, than lateral confinement by roads and highways (K. Rood, Northwest Hydraulic Consultants, email comm., July 31, 2001).

## Habitat Elements

### Channel Substrate

Lower Wenatchee River. Mission Creek delivers pulses of sediment from the Mission Creek watershed into the Wenatchee River at RM 10.4 (B. Steele, WDFW, pers. comm., 2001). The amount of sediment delivered and the extent of its effects on salmonid habitat are undetermined.

### Large Woody Debris

Lower Wenatchee River. From the mouth upstream to Tumwater Canyon (RM 25.6), there is little to no woody debris (USFS 1999c). The history of settlement and on-going development along this stream reach has reduced instream LWD and LWD recruitment, and reduced side channel/wetland habitat and the opportunity for development of side channel/wetland habitat. The altered riparian and channel conditions have also: reduced pool frequency; increased bank erosion; possibly increased channel entrenchment in stream reaches not naturally confined by glacio-fluvial terraces; altered the sediment transport regime; and altered the natural flow regime (CRITFC 1995; USFS 1999c).

### Pool Frequency

Lower Wenatchee River. Pools formation in the Lower Wenatchee River is naturally most often the result of bedrock or some other geologic feature. Pool formation is also naturally associated with LWD, however LWD is lacking in this portion of the river, and may in turn result in a lower pool frequency than would exist in a functioning system (USFS 1999c).

### Pool Depth

Lower Wenatchee River. Sediment filling in pools is a problem in depositional reaches of the Lower Wenatchee River, especially downstream of drainages with high sediment output (B. Steele, WDFW, pers. comm., 2001).

### Off-Channel Habitat

Lower Wenatchee River. Off-channel habitats are severely lacking (USFS 1999c). Channel complexity and riparian condition has been negatively impacted over time from historic log drives and floodplain/streamside development resulting in reduced riparian and wetland connectivity, a loss of aquatic species connectivity through wetlands, reduced high flow refuge, reduced sinuosity and side channel development, increased bank erosion, reduced LWD and LWD recruitment, reduced pool frequency, and a reduction in channel roughness.

Lower Wenatchee River. Placement of State Highway 2 has resulted in reduced access to off-channel juvenile rearing habitat in the Sleepy Hollow reach of the lower Wenatchee River (RM 3.5; MCHCP 1998b).

### Water Quality

#### Temperature

Lower Wenatchee River (45.0007). The Wenatchee River is listed on the 303(d) list for temperature based on water temperatures recorded at the DOE ambient water quality monitoring station, Wenatchee River at Wenatchee / #45A070, at RM 1.1 (WDOE 1998). This is DOE's one, long-term ambient water quality monitoring station on the Lower Wenatchee River. Water temperatures recorded at RM 1.1 exceeded the Class A Water state water quality criteria ( $>18^{\circ}\text{C}$ ) in July, August, or September for 5 of the 9 years from 1992 to 2000. Instream temperatures at RM 1.1 also exceed the criteria established by NMFS and the USFWS for "properly functioning" ( $>14^{\circ}\text{C}$ ) for salmon and steelhead use, every year from 1992 to 2000, with the exception of 1999 (NMFS 1996; USFWS 1998; DOE Ambient Monitoring Data at [www.ecy.wa.gov/programs](http://www.ecy.wa.gov/programs)).

A review and statistical analysis of water quality data from two long-term sampling sites in the Wenatchee subbasin (Station #45A070/Wenatchee River near Wenatchee at RM 1.1 and Station #45A110/Wenatchee River at the Hwy.2 bridge near Tumwater Campground at RM 35.6) showed a marginal increasing trend in temperature at the Wenatchee River at Wenatchee station (#45A070) at RM 1.1. Based on available data at the time of the analysis, high instream temperatures at the site near Wenatchee (along with high pH values) were seen as the major water quality concern (Ehinger 1993). Between the years 1977 and 1992, in July and September, more than 25% of the recorded temperatures at the stations exceeded state water quality standards ( $>18^{\circ}\text{C}$ ); in August,  $>50\%$  of the recorded temperatures exceeded state water quality standards (Ehinger 1993). The DOE also collected one year of water quality data in the 1970's at two other sites: #45A85/Wenatchee River near Dryden; and #45A100/Wenatchee River at Leavenworth (WDOE Ambient Monitoring Data at [www.ecy.wa.gov/programs](http://www.ecy.wa.gov/programs)).

The Chelan County Conservation District (CCCD) recorded water quality data at two sites on the Lower Wenatchee River in 1992/1993; Site #1, Monitor Bridge, which is the same location as the USGS gaging station #124625.00; and Site #8, Peshastin, which is the same as the historical USGS gage station #124590.00. Water temperatures exceeded the criteria established by NMFS and the USFWS for "properly functioning" ( $>14^{\circ}\text{C}$ ) for salmon and steelhead use at the Site #1 on: 7/19/93 ( $15.6^{\circ}\text{C}$ ), 8/16/93 ( $17.1^{\circ}\text{C}$ ), and 9/13/93 ( $14.3^{\circ}\text{C}$ ). At Site #8, criteria exceeded standards on: 7/19/93 ( $16.9^{\circ}\text{C}$ ); 8/16/93 ( $18.2^{\circ}\text{C}$ ); and 9/13/93 ( $15.3^{\circ}\text{C}$ ; Hinds 1994, Appendix 9). Again in 1999/2000, the CCCD monitored these two sites monthly as part of their "Wenatchee Watershed; Best Management Practices and Water Quality Monitoring, Quality Assurance and Data Evaluation Plan (CCCD 1999). Water temperatures exceeded the criteria established by

NMFS and the USFWS for “properly functioning” (>14°C) for salmon and steelhead use, on 8/9/00 (18.5 °C) and on 9/13/00 (14.2 °C) at the Monitor Bridge site. At the Peshastin site, water temperatures also exceeded the criteria in August and September; 8/9/00 (18.5 °C) and 9/13/00 (14.8 °C).

A single database of temperature recordings and accompanying GIS coverage of data collection stations has not been compiled and assessed. The USFS is in the process of compiling its agency’s temperature data to conduct a Wenatchee subbasin landscape analysis of temperature data. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### Fine Sediment

Lower Wenatchee River. Sediment transport is reduced by the backwater influence of the Columbia River Rock Island Dam reservoir pool (RM 453.4) in the lower Wenatchee River. As a result of the pooling effect in the Columbia River, sediment has backed-up the Wenatchee River creating a very level uniform stream bottom and “quiet” surface water (USFS 1999c). In areas of the lower Wenatchee River where spawning material are available for steelhead and spring chinook, the level of fines is believed to exceed 20% (D. Rife, USFS, pers. comm., 2000). There is no additional information on fine sediment levels in the Lower Wenatchee River.

### Water Quantity

#### Dewatering

Lower Wenatchee River. There is no information indicating the Lower Wenatchee River dewateres at any time however flows in summer and early fall months can get extremely low, negatively affecting salmonid survival and production (TAG 2001).

### Change in Flow Regime

Lower Wenatchee River. Out-of-stream water use has resulted in reduced stream flow rates and/or modified season runoff patterns on the Wenatchee River downstream of Tumwater Canyon. An analysis to determine what the natural stream flow characteristics would be in the absence of human activities has not been conducted on streams in the Wenatchee subbasin (Montgomery Water Group et al. 1995). Additionally, road density and location has increased the drainage network (USFS 1999a).

Lower Wenatchee River. In years of low snowpack, water withdrawals for irrigation and domestic use impact salmonid spawning and rearing habitat downstream of Dryden Dam (RM 17.0; CRITFC 1995; MCHCP 1998b). The lower portion of the river is on the 303(d) list for inadequate instream flows (WDOE 1998). While the percentage of flow

diverted is small in June and July, it may be significant in August through mid-October of average water years, and may have lethal impacts to juvenile salmonids in the fall of a dry year (1994 for example; MCHCP 1998b). Minimum flows have been established for the mainstem Wenatchee River (Chapter 173-545-030 of the Washington Administrative Code), however, the Columbia River Inter-Tribal Fish Commission (CRITFC) has stated that the minimum flows are not adequate to realize the spawning potential of the existing habitat (CRITFC 1995).

Lower Wenatchee River. On the Wenatchee River from the mouth upstream to Tumwater Canyon (RM 25.6), and including tributaries to this portion of the mainstem that are not addressed as separate 5<sup>th</sup> field HUC watersheds, there are 105 surface water rights permits or certificates worth a potential total diversion of 43.8 cfs. There are 204 surface water rights claims worth a potential total diversion of 411.6 cfs. There are 11 pending applications for surface water rights permits, certificates, or claims worth a potential total diversion of 5.1 cfs. There are 145 groundwater rights permits or certificates worth a potential total withdrawal of 10,520 gpm. There are 771 groundwater rights claims worth a potential total withdrawal of 15,120 gpm. There are 13 applications for groundwater rights permits, certificates or claims pending worth a potential total of 444 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### ***Middle Wenatchee River (RM 25.6 – 35.6)***

#### *Access to Spawning and Rearing*

##### Obstructions

(natural barriers are also provided here)

Middle Wenatchee River. The downstream entrance to Tumwater Canyon (RM 27.0) which is naturally narrow and therefore has high velocities, is a possible delay to salmonid migration on the mainstem Wenatchee River (USFS 1999c).

Middle Wenatchee River. Tumwater Dam (RM 31.0) is a 15-foot high diversion dam constructed in 1909 by the Great Northern Railroad to divert water for power generation for the railroad line. There is no longer any water diversion at the site. Water is now allowed to flow freely over the dam and a fish ladder has been installed to allow more efficient passage of salmonids (Hindes 1994). Prior to mid-July 2001, it was thought that migration delay concerns at Tumwater Dam had been addressed and Tumwater Dam did not pose a migration delay to salmonids (C. Peven, Chelan County PUD, pers. comm., 2001). However, around the week of July 16, 2001, extreme low flows at Tumwater dam

began hindering upstream passage of primarily sockeye salmon, but also adult summer chinook. To reestablish fish passage, changes were made at the dam that addressed flow patterns over the dam that were competing with the fish ladder's attraction flows. With the changes, fish passage was reestablished (C. Peven, Chelan County PUD, pers. comm., 2001).

### Screens and Diversions

*NOTE:* Information on the location and condition of private water diversions are not available at this time beyond what is provided below. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Middle Wenatchee River. The Alps Store has a water diversion; the status of its screen is unknown (B. Steele, WDFW, pers. comm., 2001).

### Riparian Condition

Middle Wenatchee River. Riparian habitat is naturally limited in Tumwater Canyon but has been negatively impacted by the construction of State Hwy. 2 which parallels this reach of the Wenatchee River on the east side of the river corridor. On the opposite bank, an old logging road has negatively impacted riparian habitat. These alterations have reduced riparian zone functions in the Middle Wenatchee River (TAC 2001).

### Channel Conditions/Dynamics

#### Streambank Condition

Middle Wenatchee River. Coarse sediment input and transport in Tumwater Canyon has likely been reduced by: 1) railroad construction in the late 1800's during which the Canyon bottom was narrowed and large substrate removed, consequently increasing high flow velocities and reducing coarse sediment input from the east Canyon wall (depending on very localized geologic conditions throughout the Canyon, channel degradation processes may have begun in the 1800's); 2) the construction of Tumwater Dam in the early 1900's creating 0.5 mile long Lake Jolanda, altering the sediment transport regime of the river by storing fine and coarse sediments above the dam (the depletion of these finer sized substrates below the dam has resulted in channel degradation); 3) the construction of State Highway 2 in the 1920's which continued to alter coarse sediment input from the east Canyon wall; and 4) the blasting of large boulders and log jams in the Canyon to facilitate the transport of logs downriver during the log drives which started around the turn of the century and continued until the 1930's. These activities probably resulted in a reduction in pools, an increase in gradient, increased bank erosion, and increased channel entrenchment along with reduced LWD and boulder input (USFS 1999c).

### Floodplain Connectivity

Middle Wenatchee River. Floodplain habitat in Tumwater Canyon is limited by the natural geology and connectivity is not likely appreciably reduced by human impacts (D. Rife, USFS, pers. comm., 2000).

### Width/Depth Ratio

Middle Wenatchee River. No identified concerns with increasing width/depth ratios in the literature or by professional knowledge.

### Entrenchment Ratio

Middle Wenatchee River. Coarse sediment input and transport in Tumwater Canyon has likely been reduced by: 1) railroad construction in the late 1800's during which the Canyon bottom was narrowed and large substrate removed, consequently increasing high flow velocities and reducing coarse sediment input from the east Canyon wall (depending on very localized geologic conditions throughout the Canyon, channel degradation processes may have begun in the 1800's); 2) the construction of Tumwater Dam in the early 1900's creating 0.5 mile long Lake Jolanda, altering the sediment transport regime of the river by storing fine and coarse sediments above the dam (the depletion of these finer sized substrates below the dam has resulted in channel degradation); 3) the construction of State Highway 2 in the 1920's which continued to alter coarse sediment input from the east Canyon wall; and 4) the blasting of large boulders and log jams in the Canyon to facilitate the transport of logs downriver during the log drives which started around the turn of the century and continued until the 1930's. These activities probably resulted in a reduction in pools, an increase in gradient, increased bank erosion, and increased channel entrenchment along with reduced LWD and boulder input (USFS 1999c).

### Habitat Elements

#### Channel Substrate

Middle Wenatchee River. Substrate consists of cobble as the dominant size class and small boulder as the subdominant. Survey data reflects this portion of the river is embedded; embeddedness defines as greater or equal to 35% of the larger substrate (cobble, gravel, boulders) is surrounded and/or covered by fine sediment (USFS 1994b).

#### Large Woody Debris

Middle Wenatchee River. Large woody debris recruitment and transport in Tumwater Canyon (RM 25.6 - 35.6) has likely been reduced by: 1) railroad construction in the late

1800's during which the Canyon bottom was narrowed and large substrate removed, consequently increasing high flow velocities and reducing input of LWD from the east Canyon wall; 2) the construction of Tumwater Dam in the early 1900's which changed the character of the river upstream, creating 0.5 mile long Lake Jolanda, and impairing LWD transport past the dam; 3) the construction of State Highway 2 in the 1920's which continued to alter the LWD input from the east Canyon wall; and 4) the blasting of large boulders and log jams in the Canyon to facilitate the transport of logs downriver during the log drives which started around the turn of the century and continued until the 1930's (USFS 1999c). Although the USFS has not conducted actual LWD counts in the Tumwater reach since the 1994 fire, it appears there is a fair amount of post-fire (1994) LWD recruitment occurring (D. Driscoll, USFS, pers. comm., 2001).

### Pool Frequency

Middle Wenatchee River. Coarse sediment input and transport in Tumwater Canyon has likely been reduced by: 1) railroad construction in the late 1800's during which the Canyon bottom was narrowed and large substrate removed, consequently increasing high flow velocities and reducing coarse sediment input from the east Canyon wall (depending on very localized geologic conditions throughout the Canyon, channel degradation processes may have begun in the 1800's); 2) the construction of Tumwater Dam in the early 1900's creating 0.5 mile long Lake Jolanda, altering the sediment transport regime of the river by storing fine and coarse sediments above the dam (the depletion of these finer sized substrates below the dam has resulted in channel degradation); 3) the construction of State Highway 2 in the 1920's which continued to alter coarse sediment input from the east Canyon wall; and 4) the blasting of large boulders and log jams in the Canyon to facilitate the transport of logs downriver during the log drives which started around the turn of the century and continued until the 1930's. These activities probably resulted in a reduction in pools, an increase in gradient, increased bank erosion, and increased channel entrenchment along with reduced LWD and boulder input (USFS 1999c).

### Pool Depth

Middle Wenatchee River. All pool depths are estimated to be greater than five feet deep with depths ranging from five to fifteen feet deep (USFS 1994b).

### Off-Channel Habitat

Middle Wenatchee River. Off-channel habitat is naturally limited by the confinement of the canyon (C. Raekes, USFS, pers. comm., 2001).

## Water Quality

### Temperature

Middle Wenatchee River (45.0007). Water temperatures recorded at DOE's long-term water quality monitoring station at RM 35.6 (#45A110, Wenatchee River at the Hwy.2 bridge near Tumwater Campground) exceeded Class AA Water state water quality standards ( $>16^{\circ}\text{C}$ ) 5 of 9 years (1992 – 2000) during July, August, or September (WDOE Ambient Monitoring Data at [www.ecy.wa.gov/programs](http://www.ecy.wa.gov/programs)). Between the years 1977 and 1992, in August, more than 50% of the recorded temperatures exceeded state water quality standards ( $>16^{\circ}\text{C}$ ); in September,  $>25\%$  of the recorded temperatures exceeded state water quality standards (Ehinger 1993). The recorded water temperatures of  $>16^{\circ}\text{C}$  also do not meet the temperature criteria established by NMFS and the USFWS for "properly functioning" for salmon, steelhead ( $>14^{\circ}\text{C}$ ) and bull trout use ( $>13^{\circ}\text{C}$ ; NMFS 1996; USFWS 1998).

The Chelan County Conservation District (CCCD) included site #45A110 as their one monitoring site for the Middle Wenatchee River in 1992/1993, naming it Site #20/Tumwater Canyon (Hindes 1994), and again in 1999/2000 in their "Wenatchee Watershed; Best Management Practices and Water Quality Monitoring, Quality Assurance and Data Evaluation Plan" (CCCD 1999). Water temperatures exceeded the criteria established by NMFS and the USFWS for "properly functioning" ( $>14^{\circ}\text{C}$ ) for salmon, steelhead use, and bull trout use ( $>13^{\circ}\text{C}$ ) at Site #20 on 7/20/93 ( $14.2^{\circ}\text{C}$ ), 8/17/93 ( $19.4^{\circ}\text{C}$ ), and on 9/28/93 ( $14.7^{\circ}\text{C}$ ). In 1999/2000 water temperatures exceeded criteria on 8/9/00 ( $17.3^{\circ}\text{C}$ ).

The USFS's limited data indicates that the Wenatchee River above Icicle often exceeds Forest Plan Standards. However, there is presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range for the Middle and Upper Wenatchee (D. Driscoll, USFS, pers. comm., 2001) or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing. To better address this data gap, the USFS has initiated a review and analysis of temperature data collected by the USFS in the Wenatchee subbasin (D. Driscoll, USFS, pers. comm., 2001).

### Fine Sediment

No information available.

## Water Quantity

### Dewatering

There is no information indicating the Lower Wenatchee River dewaterers at any time.

### Change in Flow Regime

Middle Wenatchee River. In general, measured stream flows from stream gauges above the City of Leavenworth have not been greatly affected by consumptive water use because the streams drain mostly undeveloped mountainous areas. Water supply for small domestic systems and a single irrigation diversion in the Upper Wenatchee River near Plain (RM 46.2) are the only uses (Montgomery Water Group et al. 1995).

Middle Wenatchee River. On the Wenatchee River from RM 25.6 (bottom of Tumwater Canyon) to RM 54.2 (Lake Wenatchee outlet), and including tributaries to this portion of the mainstem that are not addressed as separate 5<sup>th</sup> field HUC watersheds, there are 68 surface water rights permits or certificates worth a potential total diversion of 10.6 cfs. There are 85 surface water rights claims worth a potential total diversion of 4.8 cfs. There are 4 pending applications for surface water rights, certificates, or claims worth a potential total diversion of 0.8 cfs. There are 47 groundwater rights permits or certificates worth a potential total withdrawal of 3,446 gpm. There are 189 groundwater rights claims worth a potential total withdrawal of 2,241 gpm. There are 18 applications for groundwater rights permits, certificates or claims pending worth a potential total of 3,886 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### ***Upper Wenatchee (RM 35.6 – 54.2)***

#### *Access to Spawning and Rearing*

### Obstructions

(natural barriers are also provided here)

Upper Wenatchee River. The Wenatchee River originates at the outlet of Lake Wenatchee; there are no man-made or natural barriers between the mouth of the Wenatchee River and Lake Wenatchee.

## Screens and Diversions

*NOTE:* Information on the location and condition of private water diversions are not available at this time beyond what is provided below. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### Riparian Condition

Upper Wenatchee River. From Tumwater Canyon (RM 35.6) upstream to Lake Wenatchee (RM 54.2) there are numerous houses that have negatively impacted riparian bank vegetation and woody debris recruitment (CRITFC 1995; USFS 1999c). Some riprap and general bank protection projects exist in the stream reach in the vicinity of the town of Plain (RM 46.2), along with riparian clearing near some homes along the river (MCHCP 1998b).

### Channel Conditions/Dynamics

#### Streambank Condition

Upper Wenatchee River. From RM 35.6 – 48.4 (the top of Tumwater Canyon upstream to the confluence of the Chiwawa River) development along the entire river length (rural pastoral lands, housing communities, roads, power lines and railroads) may elevate sediment production from the naturally-eroding streambank terraces (USFS 1999c).

Upper Wenatchee River. From RM 48.4 – 54.2 (confluence of the Chiwawa River upstream to Lake Wenatchee) raw banks are common from where naturally-formed river terraces confine the channel somewhat. However, sediment input is not exceeding channel transport capacity (USFS 1999c), indicating the river in this reach is functioning in a stable, natural condition for sediment transport.

#### Floodplain Connectivity

Upper Wenatchee River. State Highway 207 encroaches on the floodplain near the Nason Creek confluence and has cut-off valuable floodplain for both Nason Creek and the Wenatchee River at the confluence. State Hwy 207 crosses the Wenatchee River just downstream of the Nason Creek confluence (RM 53.6), effectively acting as a dam during extreme high water events forcing all the flow down the main Wenatchee River channel (USFS 1999c).

Upper Wenatchee River. Off-channel areas (located behind Parkside Store at RM 53.0) have been eliminated from use by the Highway and subsequent development of this area (Brae Burn; USFS 1999c). The Beaver Valley Highway (State Hwy. 209), and

subsequent development located along portions of the Wenatchee River between the mouth of Lake Wenatchee and the town of Plain, encroaches upon the floodplain and cuts off a couple of old oxbows.

#### Width/Depth Ratio

Upper Wenatchee River. No identified concerns with increasing width/depth ratios in the literature or by professional knowledge.

#### Entrenchment Ratio

No information available.

#### Habitat Elements

#### Channel Substrate

No information available.

#### Large Woody Debris

Upper Wenatchee River. Between the top of Tumwater Canyon (RM 35.6) and Lake Wenatchee (RM 54.2), LWD input may be naturally limited by river terraces which confine the channel somewhat. The terraces were formed as the river cut through glacial till deposits over a period of thousands of years. Additionally, the lack of LWD today may be related to log drives down the channel from 1903-1930's, a management practice typically resulting in extreme habitat simplification (USFS 1999c). There is also a problem with wood being removed from the channel by landowners concerned about the scouring potential of in-channel wood (B. Steele, WDFW, pers. comm., 2001).

#### Pool Frequency

Upper Wenatchee River. Pool frequency is "Fair" in this section of the Wenatchee River (D. Rife, USFS, pers. comm., 2000).

#### Pool Depth

Upper Wenatchee River. Pool depth is "Good" in this section of the Wenatchee River (D. Rife, USFS, pers. comm., 2000).

## Off-Channel Habitat

Upper Wenatchee River. The impacts of State Hwy 207 as it crosses the Wenatchee River at the outlet of Lake Wenatchee, has the greatest influence on channel function in the Upper Wenatchee River (USFS 1999c). State Highway 207 crosses the head of the Wenatchee River just downstream of the Nason Creek confluence (RM 53.6), effectively acting as a dam during extreme high water events forcing all the water down the main channel. Off-channel areas (located behind Parkside Store at RM 53.0) have been eliminated from use by the Highway and subsequent development of this area (Brae Burn; USFS 1999c).

The Beaver Valley Highway (State Hwy. 209), and subsequent development located along portions of the Wenatchee River between the mouth of Lake Wenatchee and the town of Plain, encroaches upon the floodplain and cuts off a couple of old oxbows. The construction of Hwy. 209 resulted in the straightening of the channel and associated reduction in stream length, increased gradient, and in some cases caused a change in channel type (USFS 1999c).

## Water Quality

### Temperature

Upper Wenatchee River (45.0007). DOE does not maintain any long-term water quality monitoring station in the Upper Wenatchee River. The Chelan County Conservation District (CCCD) recorded water quality data, including temperature, at two sites on the Upper Wenatchee River in 1992/1993; Site #13, Plain, which is the same location as the USGS gaging station #124570.00; and Site #15, Lake Wenatchee Bridge, which is the same as the historical USGS gage station #12-45500.00. At Site # 13, water temperatures exceeded NMFS and USFWS criteria established by NMFS and the USFWS for “properly functioning” for salmon, steelhead ( $>14^{\circ}\text{C}$ ) and bull trout use ( $>13^{\circ}\text{C}$ ; NMFS 1996; USFWS 1998) on: 8/17/93 ( $16.4^{\circ}\text{C}$ ). At Site #15, water temperatures exceeded criteria on: 7/20/93 ( $14.7^{\circ}\text{C}$ ); 8/17/93 ( $18.5^{\circ}\text{C}$ ); 9/14/93 ( $16.4^{\circ}\text{C}$ ); 9/21/93 ( $14.6^{\circ}\text{C}$ ); and 9/28/93 ( $15.7^{\circ}\text{C}$ ). Again in 1999/2000, the CCCD monitored these two sites as part of their “Wenatchee Watershed; Best Management Practices and Water Quality Monitoring, Quality Assurance and Data Evaluation Plan (CCCD 1999).). Water temperatures exceeded the criteria established by NMFS and the USFWS for “properly functioning” ( $>14^{\circ}\text{C}$ ) for salmon, steelhead use, and bull trout use ( $>13^{\circ}\text{C}$ ) at Site #13 on 8/9/00 ( $17.6^{\circ}\text{C}$ ) and at Site #15 on 8/9/00 ( $19.3^{\circ}\text{C}$ ) and 9/13/00 ( $17.4^{\circ}\text{C}$ ).

The USFS’s limited data indicates that the Wenatchee River above Icicle often exceeds Forest Plan Standards. However, there is presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range for the Middle and Upper Wenatchee (D. Driscoll, USFS, pers. comm., 2001) or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or

rearing. To better address this data gap, the USFS has initiated a review and analysis of temperature data collected by the USFS in the Wenatchee subbasin. This work is being done through the Wenatchee-Okanogan Supervisor's Office (D. Driscoll, USFS, pers. comm., 2001).

#### Fine Sediment

No information available.

#### Water Quantity

##### Dewatering

There is no information indicating the Upper Wenatchee River dewatered at any time.

##### Change in Flow Regime

Upper Wenatchee River. In general, measured stream flows from stream gauges above the City of Leavenworth have not been greatly affected by consumptive water use because the streams drain mostly undeveloped mountainous areas. Water supply for small domestic systems and a single irrigation diversion near Plain (RM 46.2) are the only uses (Montgomery Water Group et al. 1995).

Upper Wenatchee River. On the Wenatchee River from RM 25.6 (bottom of Tumwater Canyon) upstream to RM 54.2 (Lake Wenatchee outlet), and including tributaries to this portion of the mainstem that are not addressed as separate 5<sup>th</sup> field HUC watersheds, there are 68 surface water rights permits or certificates worth a potential total diversion of 10.6 cfs. There are 85 surface water rights claims worth a potential total diversion of 4.8 cfs. There are 4 pending applications for surface water rights, certificates, or claims worth a potential total diversion of 0.8 cfs. There are 47 groundwater rights permits or certificates worth a potential total withdrawal of 3,446 gpm. There are 189 groundwater rights claims worth a potential total withdrawal of 2,241 gpm. There are 18 applications for groundwater rights permits, certificates or claims pending, a potential total of 3,886 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Wenatchee River Fish Distribution and Use. Table 3 describes current, known salmon, steelhead, and bull trout use in the Wenatchee River. Steelhead, spring chinook and summer chinook use the Wenatchee River for rearing and spawning and as a corridor to additional spawning and rearing habitat in the subbasin tributaries, with the exception of summer chinook. The Wenatchee River serves as the conduit for maintaining sockeye

access to Lake Wenatchee. It is also critical to allow for movement of bull trout between one population and another as they seek access to colder streams in the subbasin where they spawn and rear.

After entering the Wenatchee River in July and August, pre-spawning summer chinook adults hold in pools and under cover until late-September when spawning begins, continuing through early November (MCMCP 1998). Summer chinook spawn in the Wenatchee River from approximately the Sleepy Hollow Bridge upstream to Lake Wenatchee (RM 3.5 – 54.2), with the majority of spawning (1960 to 1999) occurring from the Leavenworth bridge upstream to Tumwater Dam (RM 23.9 – 31.0; Mosey and Murdoch 2000). The eggs then incubate over winter before the juveniles emerge from the gravels between January and April. Young summer chinook juveniles begin to move rapidly downstream, out of the Wenatchee River and into the Columbia River. This rapid exodus is most pronounced during early summer in the lower Wenatchee River (RM 0.0 – 25.6; Hillman and Chapman 1989a).

Spring chinook adult prespawners hold in the mainstem of the Wenatchee River (entry April through June, MCMCP 1998) although spawning in the mainstem (early August through September) is very limited (6.13% of total redds, 1958 – 1999; (Appendix C – Summarized spring chinook redd counts 1958-1999) and occurs only above Tumwater Canyon (RM 35.6; Mosey and Murdoch, 2000). The majority of spring chinook spawning habitat is found in the tributaries to the Wenatchee River, especially the Chiwawa River. However, given the depressed status of the stocks and the critically low returns in 1995, all known primary spawning areas are considered significant by the USFS (MacDonald et al. 2000). The Wenatchee River provides critical rearing habitat to juvenile spring chinook salmon. After emerging from the spawning gravels from late March through early May (MCMCP 1998), the juveniles will remain in the Wenatchee system over winter, migrating into the Columbia River system the following spring primarily from late April through May (MCMCP1998b). Hillman and Chapman (1989a) documented a pattern of increasing young-of-the-year juvenile chinook numbers above Tumwater Canyon (RM 36.0) in August and September. This followed an overall decrease in young-of-the-year chinook salmon in the entire mainstem Wenatchee River as young summer chinook left the Wenatchee for the Columbia River. Hillman and Chapman concluded that spring chinook juveniles moving out of tributaries probably increased salmon numbers in the upper mainstem river during autumn (1989a).

Some steelhead adults overwinter in the Upper Columbia River region after passing Rock Island dam in July. The extent of low flows in the Wenatchee River from mid-summer until the onset of winter precipitation and perhaps through winter, would determine the desirability of the Wenatchee River as overwintering habitat for adult steelhead. If conditions in the main tributaries to the Columbia River are not conducive to overwintering, adult steelhead will remain in the mainstem Columbia River until the spring runoff in late-winter/early-spring. Steelhead are known to spawn (Jan-May, MacDonald et al. 2000) in the mainstem Wenatchee River. One year of radio-telemetry data conducted by the Douglas County PUD in 1999, showed the majority of adult steelhead congregated in the mainstem Wenatchee River during the steelhead spawning

period (MacDonald et al. 2000) suggesting the mainstem Wenatchee River is the important spawning stronghold for steelhead in the Wenatchee watershed. Rainbow trout, the stream resident (non-migratory) life history form of the steelhead trout, spawn in tributaries to the Wenatchee River, contributing to the anadromous population. Juvenile steelhead/rainbow trout emerge from the gravels in late-summer of the same year in which the eggs were laid. Young trout then rear from the headwaters down through the mainstem Wenatchee River. Although numbers of both 0- and 1-age young decrease throughout the mainstem from July through October, the Middle Wenatchee River reach (Tumwater Canyon) maintained the most stable densities during that period. Steelhead/rainbow residence in the Wenatchee River system post-emergence is mostly a function of water temperature (Mullan et al. 1992). Smoltification may occur in 2 years in fish residing in the warmer mainstem or may take 7 years in colder headwaters. Most fish that do not move downstream early in life from the coldest environments are thermally-fated to a resident (rainbow trout) life history regardless of whether they were the progeny of anadromous or resident parents (Mullan et al. 1992).

Sockeye migrate up the Wenatchee River to spawn in the White and Little Wenatchee Rivers, tributaries to Lake Wenatchee (mid-September to mid-October; MCMCP 1998). Some fish may spawn along the shoreline at the upper end of Lake Wenatchee (MCMCP 1998). Juveniles move downstream from the rivers to Lake Wenatchee to rear immediately after they emerge from the gravel (March – May; MCMCP 1998). Most juveniles then spend one year in Lake Wenatchee, yet some spend two years in the lake prior to emigration. A small percentage of sockeye salmon remain in Lake Wenatchee their entire life as kokanee (MCMCP 1998). Other than the Okanogan River and upper portion of the Salmon River in Idaho, the Wenatchee River system supports the last remaining anadromous sockeye population in the Columbia River Basin (MacDonald et al. 2000).

Bull trout occur though the mainstem Wenatchee River from the Columbia River (RM 0.0) upstream to Lake Wenatchee (RM 54.2), but their numbers appear to be low (Brown 1992). The importance of the mainstem Wenatchee River to bull trout lies in maintaining unimpeded passage and adequate cover through the mainstem to support the maintenance of healthy bull trout populations in the tributaries to the Wenatchee River. The upper reaches of the Wenatchee subbasin, especially the Chiwawa River and tributaries, Nason Creek, Lake Wenatchee, the White River, and Little Wenatchee Rivers are the remaining important bull trout waters in the Wenatchee subbasin. These support what may be the healthiest bull trout populations in the subbasin with all life history forms including adfluvial and fluvial and resident, likely present.

Wenatchee River Summary. Access to and quantity of quality salmonid rearing habitat in the mainstem Wenatchee River during periods of high flow and during the late summer and early fall, is critical to sustaining salmonid production in the Wenatchee subbasin. During high flow events, lack of high velocity refugia (side channels and diverse stream margin habitat) reduces the ability of juveniles to hold in the mainstem Wenatchee River, thereby reducing the Wenatchee's rearing potential. Then, in years of low snowpack, water diversions and withdrawals for irrigation and domestic use impact salmonid

spawning and rearing habitat downstream of Dryden Dam (RM 17.0; MCMCP 1998). While the percentage of flow diverted is small in June and July, it may be significant in August through mid-October of average water years, and may have lethal impacts to juvenile salmonids in the fall of a dry year (1994 for example; MCMCP 1998).

In the mainstem Wenatchee River, habitat conditions are better upstream of the town of Leavenworth (RM 25.0) than from Leavenworth downstream. Roads, railroads, orchards, and towns have likely had some of the largest impacts on the fishery resource on the mainstem Wenatchee River, limiting the use and formation of alternate channels and access to the floodplain to disperse high flows (MCMCP 1998; USFS 1999c). The Wenatchee River is a migratory corridor for spring chinook, summer chinook, steelhead, sockeye and bull trout and important spawning and rearing habitat for steelhead, spring chinook, and summer chinook. This emphasizes the significance of the mainstem as a corridor to salmonid producing habitat in the watershed and as salmonid producing habitat in its own right. High instream water temperatures have been reported in the months of July and August throughout the entire mainstem Wenatchee River, potentially having a detrimental effect on the migration of bull trout, and the migration/rearing of steelhead trout (Ehinger 1993).

In the Lower Wenatchee (RM 0.0 – 35.6), the history of settlement and on-going development (including roads, railroads, orchards and towns) has altered the riparian and channel condition resulting in: floodplain abandonment; reduced sinuosity; increased channel entrenchment; reduced side channel/wetland habitat; reduced LWD input/pool frequency; increased bank erosion; increased sediment loads/deposition; and reduced instream flows (CRITFC 1995; USFS 1999c). From the bottom of Tumwater Canyon (RM 25.6) downstream to the mouth, there is little to no woody debris. Wood generally contributes to the creation of pools, traps sediments, and influences the location of the thelweg. In the absence of LWD, pools formation is dependent on bedrock conditions, boulder placement, or some other geologic feature. Some of the Wenatchee River, especially near Sleepy Hollow Bridge (RM 3.5) is braided, allowing for shallower waters and increased temperatures. This reach has experienced a high degree of alteration from orchards, roads, railroads, towns and bridges. Off-channel habitats are severely lacking; this is also likely the cause of the lack of LWD and channel constriction which increases instream velocities during high flow events (USFS 1999c).

The biggest negative influence to habitat in the Upper Wenatchee (RM 35.6 – 54.2) is the placement of State Highway 207 as it crosses at the head of the river. This effectively acts as a dam during extreme high water events forcing all the flow down the main Wenatchee River channel (USFS 1999c). Off-channel areas (located behind Parkside Store at RM 53.0) have been eliminated from use by the Highway and subsequent development of this area (Brae Burn; USFS 1999c).

## **Derby Canyon Drainage.**

Derby Canyon Description. This drainage is 8,500 acres in size. Derby Canyon Creek enters the Wenatchee River at RM 19.0, a few miles above the Wenatchee River/Peshastin Creek confluence. Derby Canyon Creek has an estimated 0.1% of the flow of the Wenatchee River USFS B.A. for the Mainstem Wenatchee River 1999, pg. 4).

Derby Canyon Discussion of Hydrogeology and Habitat Conditions. In the Mainstem Wenatchee Watershed, below Chumstick Creek, Derby Canyon Creek is the only perennial stream flowing into the Wenatchee River (USFS 1999c). Woody debris is essentially non-existent in Derby Canyon Creek and in places, the channel is very entrenched with high amounts of fine sediment, up to one foot in places. The sand stems from a variety of factors including the natural sandstone formations and migration from roads and other management activities. Currently the amount of fine sediment seems to be exceeding the channel's transport capacity. The deep entrenchment is likely due to reduced sinuosity and reduced riparian vegetation as a result of road confinement. The stream is generally in a degradation mode from near continuous channel adjustments to the sediment load (USFS 1999c). Fisheries concerns are related mostly to increased fine sediment production, confinement of the floodplain, potential increases in temperatures from reduction in shading, and loss of processes like temperature regulation, LWD input, and bank stability resulting from the location of roads in riparian corridors (USFS 1999c).

Derby Canyon Current Known Habitat Conditions. The following listed information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### Access to Spawning and Rearing

#### Obstructions

(natural barriers are also provided here)

Derby Canyon Creek (45.0386). A total of 17 culverts were identified on private and USFS lands from the mouth upstream to RM 1.8 (Harza/Bioanalysts 2000; USFS Culvert Barriers Database 2000). Seven of the culverts were determined to be fish passage barriers; the first two within 50 feet of one another at RM 0.8 and the upstream-most identified barrier culvert at RM 1.8. However, adult steelhead trout are known to occur up to RM 3.0 (B. Steele, WDFW and D. Rife, USFS, pers. comm., 2000) with landowners along the lower mile of Derby Canyon Creek report occasional sightings of

adult steelhead (USFS 1999a). Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

Derby Canyon CreekDerby Canyon Creek. There are a few instream, private ponds in Derby Canyon Creek (exact locations unknown) that may affect fish passage (D. Driscoll, USFS, pers. comm., 2001).

### Screens and Diversions

*NOTE:* Information on the location and condition of private water diversion are not available at this time. It is anticipated that this data gap will be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### Riparian Condition

Derby Canyon Creek. The lower 2 miles of the creek have numerous houses, ponds, pastures and associated habitat degradation that include riparian vegetation removal, channel confinement by roads, and channel constrictions by numerous stream crossing structures. The USFS Road 7400, parallels the creek to its headwaters (USFS 1999c). Subsequently, Derby Canyon Creek is very entrenched with high amounts of fine sediment deposits in depositional reaches. The sand stems from a variety of factors including the natural sandstone formations, migration from roads and other management activities. Impacts include loss of floodplain function as a result of entrenchment, potential increases in temperatures from reduction in shading, and loss of processes such as temperature regulation, LWD input and bank stability (USFS 1999c).

### Channel Conditions/Dynamics

### Streambank Condition

Derby Canyon Creek. Bank stability is a concern in Derby Canyon Creek (USFS 1999c). Derby Canyon Creek is very entrenched with high amounts of fine sediment deposits. The sand stems from a variety of factors including the natural sandstone formations, migration from roads and other management activities. The deep entrenchment is likely the result of channel confinement and riparian habitat impacts related to the placement of USFS Road 7400, which parallels the creek and crosses the stream (USFS 1999c), and private development in the lower two miles.

### Floodplain Connectivity

Derby Canyon Creek. There are numerous houses, ponds, pastures and associated habitat degradation in the lower two miles of the creek. The USFS Road 7400 parallels the creek and crosses the stream, confining the channel and reducing riparian habitat functions (USFS 1999c). The channel is also highly entrenched with high amounts of fine sediment deposits. The sand stems from a variety of factors including the natural sandstone formations, migration from roads and other management activities. Overall, the habitat degradation in Derby Canyon Creek contributes to a loss in floodplain function, although the full extent is not known.

### Width/Depth Ratio

Derby Canyon Creek. No identified concerns with increasing width/depth ratios in the literature or by professional knowledge.

### Entrenchment Ratio

Derby Canyon Creek. Derby Canyon Creek is very entrenched with high amounts of fine sediment deposits. This is likely the result of channel confinement and riparian habitat impacts related to the placement of USFS Road 7400, which parallels the creek and crosses the stream at RM 2.5 at the junction with the FS Road 7401 (USFS 1999c).

### Habitat Elements

#### Channel Substrate

No information available.

#### Large Woody Debris

Derby Canyon Creek. Woody debris and LWD recruitment is essentially non-existent, the channel is very entrenched, and currently the amount of fine sediment in the stream seems to be exceeding the channel's transport capacity (USFS 1999c). The sand stems from a variety of factors including the natural sandstone formations and sediment delivery from roads and other management activities. The deep entrenchment is likely due to the effects of channel confinement and riparian habitat impacts related to the placement of USFS Road 7400, which parallels the creek and crosses the stream (USFS 1999c). The lower 2 miles has numerous houses, ponds, pastures and associated habitat degradation. The stream is generally in a degradation mode as the channel continually attempts to adjust to the sediment loading (USFS 1999c).

### Pool Frequency

Derby Canyon Creek. Road development and location associated with low pool-forming wood recruitment and pool filling from high sediment loading contributes to low pool frequency and pool depth (USFS 1999a). The stream is generally in a degradation mode as the channel continually attempts to adjust to the sediment loading (USFS 1999c).

### Pool Depth

Derby Canyon Creek. Road development and location associated with low pool-forming wood recruitment and pool filling from high sediment loading contributes to low pool frequency and pool depth (USFS 1999a). The stream is generally in a degradation mode as the channel continually attempts to adjust to the sediment loading (USFS 1999c).

### Off-Channel Habitat

Derby Canyon Creek. There are numerous houses, ponds, pastures and associated habitat degradation in the lower two miles of the creek including USFS Road 7400 which parallels the creek and crosses the stream at RM 2.5, confining the channel and reducing riparian habitat functions (USFS 1999c). The channel is also highly entrenched with high amounts of fine sediment deposits. The sand stems from a variety of factors including the natural sandstone formations, migration from roads and other management activities. Overall habitat degradation in Derby Canyon Creek contributes to a loss of side-channel forming.

### Water Quality

#### Temperature

Derby Canyon Creek. Riparian habitat degradation and conversion of the lower reaches to rural land uses have resulted in and a loss of ecosystem processes that provide functions such as instream temperature regulation. However, there is presently no data to determine if these temperatures are significantly different than temperatures in the historic range nor to what extent, if any, these temperatures negatively impact salmon use in Derby Canyon Creek.

#### Fine Sediment

Derby Canyon Creek. Derby Canyon Creek is the only perennial tributary to the Wenatchee River in the Mainstem Wenatchee River watershed (HUC 5) below Tumwater Canyon (RM 25.6), and is naturally capable of transporting great amounts of sediment (Rosgen channel types B and G). However, currently the amount of fine sediment seems

to be exceeding the channel's transport capacity (USFS 1999c). In places, the channel is very entrenched with high amounts of fine sediment, up to one foot deep in places. The sand stems from a variety of factors including the natural sandstone formations and migration from roads and other management activities. The deep entrenchment is likely due to the effects of channel confinement and riparian habitat impacts related to road placement.

Large woody debris is essentially non-existent and USFS Road 7400 parallels and crosses the stream. The lower two mile reach has numerous houses, ponds, pastures and associated habitat degradation (USFS 1999c). The stream is generally in a degradation mode as the channel continually attempts to adjust to the sediment loading (USFS 1999c).

### Water Quantity

#### Dewatering

Derby Canyon Creek. The channel dewateres from the RM 1.0 downstream to the mouth (B. Steele, WDFW, pers. comm., 2001).

#### Change in Flow Regime

Derby Canyon Drainage-wide. There are 8 surface water rights permits and certificates worth a potential total diversion of 0.4 cfs. There are 6 surface water rights claims worth a potential total diversion of 1.1 cfs. There are no pending applications for surface water rights, certificates, or claims. There are 3 groundwater rights permits and certificates worth a potential total withdrawal of 190 gpm. There are 9 groundwater rights claims worth a potential total withdrawal of 171 gpm. There is 1 application for groundwater rights permits, certificates or claims pending worth a potential total of 20 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Derby Canyon Creek. Return flows from the Wenatchee Irrigation District supplement stream flows during irrigation season (B. Steele, WDFW, pers. comm., 2001).

Derby Canyon Creek. Moderate harvest levels and road densities of 2.8 mi./sq.mi in a sensitive landtype have Derby Creek functioning at risk for altered peak/base flow (USFS 1999a). Road density and location (4.4 mi/mi<sup>2</sup> of road within 300' of the stream) and development have also increased the total drainage network (USFS 1999a).

Derby Canyon Fish Distribution and Use. Table 3 describes current, known salmon, steelhead, and bull trout use in Derby Canyon. Spring chinook do not occur in Derby Canyon Creek and likely did not occur there historically. Bull trout may not have occurred there historically and are not known to occur there now. Seventeen culverts were identified on private and USFS lands from the mouth upstream to RM 1.8 (Harza/Bioanalysts 2000; USFS Culvert Barriers Database 2000). Seven of the culverts were determined to be fish passage barriers; the first two within 50 feet of one another at RM 0.8 and the upstream-most identified barrier culvert at RM 1.8). However, adult steelhead trout are known to occur up to RM 3.0 (B. Steele, WDFW and D. Rife, USFS, pers. comm., 2000) with landowners along the lower mile of Derby Canyon Creek report occasional sightings of adult steelhead (B. Steele, WDFW, pers. comm., cited in the B.A. for the Mainstem Wenatchee, 1999, pg. 3). Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

Derby Canyon Summary. Derby Canyon Creek contributes a very small percentage (0.1%) of the Wenatchee River's total flow, and with settling ponds near the mouth, is not thought to be a significant source of downstream water quality concerns. Salmonid production potential exists naturally only for steelhead/rainbow trout. This production potential is naturally low due to the limited hydrology and natural channel characteristics of the drainage which limit habitat and habitat access. Derby Canyon Creek is in a highly degraded condition for almost all habitat attributes. The lower two miles is in private or state ownership with numerous houses, ponds, pastures and associated problems. Forest Road 7400 parallels and crosses the stream. Woody debris is essentially non-existent except for brush that dominates the riparian area (USFS 1999c).

### **Chumstick Creek Drainage**

Chumstick Creek Drainage Description. The Chumstick Creek drainage is 47,000 acres in size (USFS 1999b). Chumstick Creek and Eagle Creek (RM 1.9), a tributary to Chumstick Creek, are the only streams in the drainage known to support anadromous salmonids. Mean annual precipitation ranges from 20 inches in valley bottoms to 50 inches in the higher elevations (USFS 1999b). Along the mainstem and major tributaries, much of the valley bottom is in private ownership and with low-density housing the predominant use, and including pasture and agricultural development all in the floodplain. The higher elevations are in USFS ownership (USFS 1998a). Chumstick Creek County Road parallels Chumstick Creek its entire length with multiple crossings. All major tributaries have county roads, forest service roads or private roads paralleling the stream channel with multiple crossings.

Chumstick Creek flows into the Wenatchee River at RM 23.5 at the east end of the town of Leavenworth. It contributes 0.2% of the low flow to the Wenatchee River just (USFS

1999b). No historic stream flow data is available for Chumstick Creek, but substrate and mean elevation make it comparable to other dry systems on the Wenatchee National Forest (i.e. Posey Canyon; USFS 1999b). Currently, a joint project is underway between the Chumstick Watershed Association, USFWS, USFS, and WDOE to characterize the flow regime of Chumstick Creek. Preliminary results indicate peak flows in March or April, with a 1997 flow of 85 cfs. Low flows occur in August or September and in 1998 were 2.0 cfs (USFS 1999b). Eagle Creek flows into the Chumstick River at RM 1.9. It has one perennial tributary, Van Creek. Mullan et al. (1992) provides the following information for the Eagle Creek drainage; 10.3 miles in length, 4% gradient, 28 square mile drainage, 0-3 cfs. - low or minimum discharge. The current channel condition is generally described as poor by the USFS (USFS 1999b).

#### Chumstick Creek Drainage Discussion of Hydrogeomorphology and Habitat Conditions.

The combination of easily weathered sedimentary landtypes, numerous mass wasting features, and bedrock control of drainage patterns has helped to deliver large amounts of finer sediments to valley bottoms resulting in well developed floodplain deposits. These thick alluvial deposits have lowered the water table and stream flow is intermittent for the majority of channels in the drainage. Where perennial flows exist, stream flow is sometimes interrupted where strata directs groundwater to deeper aquifers. Stream channels are mostly moderate in gradient (2-4, 4-8, 8-12%) and bank and channel substrate is mostly sandy material. The main Chumstick Valley, portions of Eagle Creek, and several small segments of debris-dammed channels are response reaches, major tributaries are primarily transport reaches, and tributary headwaters and first or second order drainages are generally source reaches (USFS 1999b).

High fine sediment levels within the drainage can be linked to a number of sources both natural and management related. These include erosion from roads and riparian habitat degradation, erosion from hill slopes as a result of fire, erosion from natural hill slope processes in highly erodible soils, and possibly hillslope erosion from historic and continued grazing (USFS 1999b). Many of the channel roughness features (larger substrates, LWD) are absent or too small and unstable which contribute to further channel degradation through bank and channel cutting, adding more fine sediment to the system (USFS 1999b). Degraded riparian habitat is linked to lack of LWD and sediment delivery (USFS 1999b). Agricultural and urban encroachment, historic railroading and logging, and high riparian road densities contribute to increased surface erosion, channel confinement, and channel degradation (USFS 1999b). A county road culvert barrier at RM 0.3 inhibits passage of steelhead into Chumstick Creek and fully impedes upstream passage of spring chinook. Twenty-two additional culverts have been identified as fish passage barriers upstream of RM 0.3 on Chumstick Creek. A joint effort by the local landowners, the Conservation District, the NRCS, BPA, and the USFWS, is underway to fund the repair or replacement of all fish passage barriers in the Chumstick drainage.

Chumstick Creek Drainage Current Known Habitat Conditions. The following list of information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field

biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### Access to Spawning and Rearing

#### Obstructions

(natural barriers are also provided here)

Chumstick Creek (45.0402). The North Road county culvert at RM 0.3 is a full passage barrier to spring chinook and a partial passage barrier to steelhead (USFWS 2000).

Chumstick Creek. Following 1995 and 1996 floods, and to aid in identifying potential stream restoration projects, the USFWS in cooperation with the NRCS surveyed Chumstick Creek from the mouth upstream to the Little Chumstick Creek (RM 0.0 – 8.7), in November 1996 (Mitchell and Lobos 1996; Titus 1997). In this post-flood damage assessment, NRCS identified 28 culverts on Chumstick Creek between the mouth upstream and the confluence of Little Chumstick Creek (RM 0.0 – 8.7; Mitchell and Lobos 1996) Culverts were inventoried by the NRCS for size, grade, alignment, stability, and pool formation. The USFWS stream survey of the same portion of Chumstick Creek (Titus 1997), made determinations regarding fish passability at each of the culverts by comparison to the Hydraulic Code rules (WAC Chapter 220-110). Based on data and observations at the time of the survey, Titus commented that nine of the 28 culverts “may present passage problems”. Water velocities were not measured so could not be compared to fish passage guidelines in the WAC at the time of the survey, therefore Titus (1997) recommended that water velocities be measured through all permanent culverts to accurately determine if a culvert meets WAC specifications for fish passage prior to restoration work. More recently, the USFWS (2000) has determined that at least 23 culverts on Chumstick Creek act as barriers during all flows and 9 culverts are considered to be low flow barriers. As regards current PUD telemetry data identifying known steelhead occurrence upstream of culverts identified as presenting potential fish passage barriers, this can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability of salmonids and pass through an “impassable” culvert given the “right” conditions, in some years.

Eagle Creek (45.0404). A beaver pond between RM 3.0 and 4.0 on Eagle Creek is a fish passage barrier (USFS 1998a).

#### Screens and Diversions

*NOTE:* Information on the location and condition of private water diversion are not available at this time. This data gap should be addressed in the Wenatchee WRIA 45

Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### Riparian Condition

Chumstick Creek. Forty percent of the riparian vegetation along the mainstem Chumstick and Eagle creeks, in addition to other smaller tributaries, has been disturbed by agricultural and urban encroachment, historic railroad development, logging, and high riparian road densities (USFS 1999b). Undisturbed areas have a dense riparian zone (Titus 1997). Where disturbance has occurred there is increased surface erosion, channel confinement, and associated channel degradation. In the disturbed areas where woody vegetation is lacking, soil is bare and an invasive weed (reed canary grass; *Phalaris arundinacea*) is abundant. High sediment levels and lack of channel roughness features such as LWD, are linked to the degraded riparian habitat condition of Chumstick Creek (USFS 1999b). Mullan et al. (1992) reported that the entire stream area of 10 acres accessible to anadromous salmonids has been degraded by agricultural and urban encroachment. Where woody vegetation occurs, shrubs are usually most common with red-osier dogwood (*Cornus Stolonifera*) the dominant woody plant. Willow (*salix spp.*), alder (*Alnus spp.*), snowberry (*Symphoricarpos albus*), and wild rose (*Rosa spp.*) can be found in more intact riparian areas. Cottonwood (*Populus balsamifera*) and hawthorn (*Crataegus douglasii*) trees still occur on some sections of Chumstick Creek (Mitchell and Lobos 1996; Titus 1997).

Eagle Creek. Riparian condition is “Poor” for Eagle Creek (D. Rife, USFS, pers. comm., 2000).

### Channel Conditions/Dynamics

#### Streambank Condition

Chumstick Creek. Erosion associated with riparian disturbance and culvert placement has been recorded from the North Road culvert (RM 0.3) upstream to Little Chumstick Creek (8.7; Titus 1997). Active erosion is highest from Eagle Creek (RM 1.9) to Sunitsch Canyon (RM 5.0; Titus 1997).

Eagle Creek. Streambank condition is “Poor” for Eagle Creek (D. Rife, USFS, pers. comm., 2000).

#### Floodplain Connectivity

Chumstick Creek. Highway 209 and the Burlington Northern Railroad closely parallel Chumstick Creek channelizing the creek, limiting the width of the riparian zone and restricting the use of its floodplain (Titus 1997). High densities of riparian roads do the same thing in the tributaries (USFS 1999b).

Eagle Creek. Floodplain connectivity is “Poor” for Eagle Creek (D. Rife, USFS, pers. comm., 2000).

#### Width/Depth Ratio

Chumstick Creek. No indication of width/depth ratio concerns were provided in the literature or through professional knowledge.

#### Entrenchment Ratio

Chumstick Creek. Chumstick Creek is confined by Highway 209 and the Burlington Northern Railroad restricting the use of its floodplain and likely reducing channel sinuosity. Sinuosity from the mouth to Little Chumstick Creek (RM 8.7) is lower than expected for such a low gradient stream segment (<1.5%; Titus 1997). Coupled with high sediment yields, low LWD levels, and a flashy hydrology (USFS 1999b), Chumstick Creek is considered at risk for becoming entrenched by developing a decreasing width-to-depth ratio (USFS 1998a).

#### Habitat Elements

##### Channel Substrate

Chumstick Creek. Observations indicated that substrates in the riffles from RM 0.3 to RM 8.7 at Little Chumstick Creek were frequently embedded. Embeddedness was rated by observing the sediment surrounding the substrate. Substrate was considered embedded if >35% of the particle was surrounded by fine sediment (Titus 1997).

Eagle Creek. Channel substrate is “Poor” for Eagle Creek (D. Rife, USFS, pers. comm., 2000).

##### Large Woody Debris

Chumstick Creek. Instream LWD throughout the watershed is lacking in adequate dimensions (USFS 1999b). Large woody debris reduction is the result of timber harvest practices and associated road development, grazing, and development of the floodplain for agriculture and homes. In the lower 1.8 miles of Chumstick Creek (to the Eagle Creek confluence), zero pieces of woody debris >12 inches in diameter and > 35 feet in length (LWD) were found (Titus 1997). Only 6 pieces of LWD were found from Eagle Creek to Sunitsch Canyon at RM 5.1 (a 3.5 mile reach; Titus 1997). From Sunitsch Canyon upstream to Little Chumstick Creek 16 pieces of LWD were found but included in this count were standing large cottonwoods growing within the channel bankfull width (Titus 1997). The loss of the large diameter tree component in the watershed from timber harvest practices have further reduced the potential for LWD recruitment (USFS 1999b). As a result of LWD deficiencies, sediment is flushed through the system at high flows

instead of being trapped and stored, scouring the stream channel and increasing fine sediment delivery to valley bottom channels (USFS 1999b).

Eagle Creek. Large woody debris is “Poor” for Eagle Creek (D. Rife, USFS, pers. comm., 2000).

#### Pool Frequency

Chumstick Creek. There is an acceptable amount of pool habitat, however the depth in many pools does not provide sufficient refuge for fish during low flow periods (Titus 1997).

Eagle Creek. Pool frequency is “Poor” for Eagle Creek (D. Rife, USFS, pers. comm., 2000).

#### Pool Depth

Chumstick Creek. The depth of many pools in Chumstick Creek do not provide sufficient refuge for fish during low flow periods. Average pool depth in the lower 8.7 miles was <2.3 feet (Titus 1997; USFS 1999b).

Eagle Creek. Pool depth is “Poor” for Eagle Creek (D. Rife, USFS, pers. comm., 2000).

#### Off-Channel Habitat

Chumstick Creek. No side channels exist from the North Culvert Road (RM 0.3) to the Little Chumstick Creek confluence (RM 8.7). The average gradient in this same section of stream is <1.5% (Titus 1997). Highway 209 and the Burlington Northern Railroad closely parallel Chumstick Creek channelizing the creek and limiting the width of the riparian zone and floodplain (USFS 1999b).

Eagle Creek. Off-channel habitat is “Poor” for Eagle Creek (D. Rife, USFS, pers. comm., 2000).

#### Water Quality

##### Temperature

Chumstick Creek. The Chelan County Conservation District (CCCD) monitored water temperature at five stations in Chumstick Creek in 1999 and 2000 (CCCD 1999). No exceedences of instream temperature criteria established by NMFS for “Properly Functioning” condition of salmon and steelhead (14°C) was recorded in 1999/2000 at Site #11cc/North Road Culvert. Few temperature recordings in excess of 14°C were

recorded at any of the other four temperature recording sites on Chumstick Creek. However, there is presently not sufficient data to determine if high instream temperatures exist that affect salmonid use in Chumstick Creek.

Eagle Creek. The Chelan County Conservation District (CCCD) monitored water temperature at one station located near the mouth on Eagle Creek in 1999 and 2000 (CCCD 1999). The highest recorded water temperature was recorded on 8/8/00 at 14.7°C, barely exceeding the criteria for “Properly Functioning” established by the NMFS for salmon and steelhead (14°C). However, there is presently not sufficient data to determine if instream temperature exceedences exist that affect salmonid use in Eagle Creek.

#### Fine Sediment

Chumstick Creek. Fines observed in riffles from the North Road culvert to Little Chumstick Creek (RM 0.3 – 8.7) range from 29 – 36% and are considered excessive. High fine sediments within the Chumstick Creek drainage can be linked to a high, naturally occurring level exacerbated by erosion from roads and riparian habitat degradation, erosion from burned areas, and possibly hillslope erosion from historic and continued grazing (USFS 1999b).

#### Water Quantity

##### Dewatering

Watershed-wide. As is typical in drainages in the drier portion of the Wenatchee subbasin, stream flow is intermittent for the majority of tributaries in the drainage. Where perennial flow exists, stream flow is sometimes interrupted when the underlying water table drops low enough that surface flows go subsurface (USFS 1999b). Ground water withdrawals may also have a negative effect on maintaining perennial flows.

Chumstick Creek. Preliminary results from 1998/2003 joint USFS, Chumstick Watershed Community Association (CWCA), WDOE, and USFWS instream flow measurements showed that late summer discharge decreased going from upstream to downstream, indicating Chumstick Creek has a possible losing reach. This may be due to shallow aquifer well withdrawals throughout the valley (USFS 1999b). However, flows have been observed to go subsurface during dry summer months (Hindes 1994), sometimes reappearing when summer rains may recharge the water table, then again going subsurface (L. Ott, CWCA, pers. comm., 2001).

##### Change in Flow Regime

Watershed-wide. There are 54 surface water rights permits or certificates worth a potential total diversion of 8.2 cfs. There are 99 surface water rights claims worth a

potential total diversion of 36.4 cfs. There are no pending applications for surface water rights, certificates or claims. There are 103 groundwater rights permits and certificates worth a potential total withdrawal of 2,194 gpm. There are 61 groundwater rights claims worth a potential total withdrawal of 1,215 gpm. There are 7 applications for groundwater rights permits or certificates pending worth a potential total of 250 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Chumstick Creek. Chumstick Creek is on the Washington State 303(d) list for Instream Flows with a flow of less than 0.1 cfs recorded just above the confluence of Little Chumstick Creek on 9-14-93. Given the possible effects of extensive loss of vegetation to harvest and land conversion, and also high road densities, on peak and baseflows, Chumstick Creek is functioning at risk for altered hydrology (USFS 1998 a). Private land development throughout the drainage has affected instream flows via groundwater withdrawals from private wells (USFS 1999b). Past timber harvest activities have removed the large tree component in the drainage and thick stands of small tree conifers dominate (USFS 1999b). High road densities occur throughout the watershed and many are located in valley bottoms (USFS 1999b). Road density in lower Chumstick, upper Chumstick and Eagle subwatersheds is 3.0, 4.0 and 4.0 miles/sq.mi respectively (USFS 1998a).

Chumstick Creek. Mullan et al. (1992) cited Bryant and Parkhurst (1950) as saying the reduction in stream flows related to domestic water diversion reduced the value of Chumstick Creek for anadromous species. Chumstick Creek is listed on the 303(d) list for instream flows (WDOE 1998). Presently, there is a joint project underway between the USFWS, DOE, USFS and the Chumstick Watershed Community Association (CWCA) to characterize the flow regime of Chumstick Creek. The CWCA has established stream gages at various locations on Chumstick Creek and monitors them regularly.

Eagle Creek. Mullan et al. (1992) cited Bryant and Parkhurst (1950) as saying the reduction in stream flows related to domestic water diversion reduced the value of Eagle Creek for anadromous species.

Chumstick Creek Drainage Fish Use and Distribution. Table 3 describes current, known salmon, steelhead, and bull trout use in the Chumstick Creek drainage. Historically, spring chinook, winter steelhead and coho spawned and reared in lower Chumstick and lower Eagle creeks. Run sizes are unknown but were likely naturally small for steelhead and spring chinook (possibly less than 100 returning adults; USFS 1999b). Coho could have been a substantial part of the population in the Chumstick drainage prior to development, where meandering channels with beaver ponds, back waters and side channels would have favored coho rearing (USFS 1999b). Given its elevation and

landtype, the Chumstick Creek drainage may never have supported significant bull trout populations even under historic conditions when water temperature, flows and substrate composition may never have been optimal for bull trout (USFS 1998a).

Today, spring chinook use is limited to rearing in the first 0.3 miles of Chumstick Creek by the North Road county culvert. Coho have been extirpated from the region and no documented sightings of bull trout exist for the drainage (USFS 1998a). Brook trout are present throughout the entire drainage (USFS 1999b). Results of an ongoing radio telemetry study conducted on steelhead trout by the Douglas County PUD located adult steelhead trout in Chumstick Creek in 2000. The telemetry results showed adult steelhead as far as 5.7 miles upstream of the mouth of Chumstick Creek, establishing that in the year 2000, adult steelhead did pass upstream of the North Road culvert (RM 0.3). Eagle Creek is the only tributary to Chumstick Creek that is known to support anadromy; the upper extent of known rainbow/steelhead trout anadromy in Eagle Creek is approximately RM 1.0 (Mullan et al. 1992). Rainbow/steelhead trout are present throughout the watershed.

Chumstick Creek Drainage Summary. Impacts from private land development, and road densities on Forest Service lands, are the most important issues in this drainage (USFS 1998a) and are driving habitat degradation. Chumstick Creek is in a highly degraded condition for almost all habitat attributes except pool frequency; pools are associated with culverts. Many of the highly degraded habitat attributes can be attributed to a loss of stream channel function resulting from road density and location, loss of floodplain connectivity, and alteration of disturbance regimes. Additionally, instream flows are very low (2.0 cfs in August/September - USFS 1999b; 9.07 cfs in mid-November 1996 just above the North Road Culvert - Titus 1997), upstream access is blocked by multiple stream crossings, water quality is degraded, and high fine sediments may limit spawning success and food production (macroinvertebrate communities). The Chumstick Creek drainage has been identified as one of the more problematic watersheds in the entire Wenatchee subbasin (Hindes 1994) relative to land use impacts and management issues. Given restoration of fish passage, degraded habitat quality and low flow conditions will continue to limit salmonid production.

The natural channel characteristics of Chumstick Creek could lend themselves to a high potential for coho production, given reintroduction. These same natural channel characteristics however, are not particularly conducive to spring chinook production, although that is not to say spring chinook did not occur in Chumstick Creek historically (K. MacDonald, USFS, pers. comm., 2001). Steelhead/rainbow trout production has a high potential in the watershed, with spawning and rearing supported by habitat in Chumstick Creek and rearing potential throughout the watershed where hydrology exists and barriers do not stop upstream fish passage. Currently, some steelhead successfully navigate the Chelan County North Road culvert in years when the hydrology supports passage; steelhead use in the watershed is known to extend up to RM 5.7 on the mainstem and to RM 1.0 on Eagle Creek. Non-native brook trout and anadromous salmonid stocks have been stocked in the watershed and are present throughout.

## **Chiwaukum Creek Drainage.**

Chiwaukum Creek Drainage Description. This drainage is 50 square miles (32,000 acres) in size, located northwest of the town of Leavenworth. Elevation at the mouth is 1,666 feet. Chiwaukum Creek (RM 36.0) flows into the Wenatchee River near the head of Tumwater Canyon (RM 35.6).

The only tributary known to support anadromous salmonids in the Chiwaukum Creek drainage is Skinney Creek. Skinney Creek is 6,925 acres in size, flowing into Chiwaukum Creek at RM 0.6. Average annual precipitation in Skinney Creek ranges from 35 inches near the mouth to 50 inches at higher elevations. The valley floor of Skinney watershed is entirely privately owned and contains substantial rural development; hayfields, the Winton lumber mill, State Highway 2, a railroad line, and high voltage powerlines. The Wenatchee Watershed Assessment (USFS 1999c) describes Skinney Creek as severely impacted by the railroad, highway, farming, and timber harvest. Fish barrier culverts near the mouth impede fish passage into Skinney Creek.

Chiwaukum Creek Drainage Discussion of Hydrogeomorphology and Habitat Conditions. This drainage represents the only classic U-shaped glacial valley in the Mainstem Wenatchee River watershed as described in the USFS Mainstem Wenatchee Watershed Analysis 1999, pg. 45). Collapsed glacial till deposits influence channel character by creating stream obstructions which affect gradient and base levels. Aggradation has occurred upstream of the deposits and degradation processes below. Glacial till on valley floors also shape debris flow processes which regulate channel form and provide wood and substrate to channels. As a result of these processes, Chiwaukum Creek is a pool-riffle channel in its lowest segments, predominantly a step-pool system in the middle sections, and cascading in its headwaters. The channel has remained relatively stable despite several irrigation diversions and even a historic dam. More recent management is recreation based with the USFS Tumwater Campground at the mouth and dispersed sites located further upstream. Loss of riparian vegetation has increased streambank erosion in some small, very localized places. The location of the Tumwater Campground limits the natural migration of the channel over its floodplain and flood control measures have been taken to protect the campground (USFS Mainstem 1999c). Ten excursions beyond the state criterion have placed Chiwaukum Creek on the 303(d) list for temperature (WDOE 1998). As this drainage is essentially unmanaged, this may be the natural temperature regime (M. Karrer, USFS, pers. comm., 2001).

In the headwaters of the Skinney Creek drainage flows naturally become intermittent (USFS 1999c). Present day features of the channel include a wide valley, wetted riparian zone, sinuous stream, and finer sediments. These features are attributable to an impoundment created thousands of years ago by a terminal moraine located near Hatchery Creek at RM 35.2 on the Wenatchee River. Today, the channel has downcut in response to road confinement by Highway 2. Combined with agriculture and timber harvest practices, fish habitat has been limited by decreasing woody debris input and increasing sediment input (USFS 1999c). This has created a more entrenched channel

reducing the channel's ability to access its floodplain (USFS 1999c). Additionally, overall road density in the watershed is high (3.4 mi./sq. mi.), with a substantial portion of the roads lying in riparian areas. Upstream of RM 2.0, near the Winton Mill, an irrigation diversion and associated pond have also contributed to channel entrenchment downstream.

Chiwaukum Creek Drainage Current Known Habitat Conditions. The following list of information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### Access to Spawning and Rearing

#### Obstructions

(natural barriers are also provided here)

Chiwaukum Creek. From the mouth upstream to about RM 0.6, where the stream flows beside the Tumwater Campground, at low flows campers have been observed to build up small dams using the cobbles in the stream bed, to pool water. This may disrupt fish passage (D. Driscoll, USFS, pers. comm., 2001).

Chiwaukum Creek (45.0700). At low flows, the drop structure under the State Hwy. 2 crossing (just downstream of the Skinney Creek confluence at RM 0.6) may negatively impact juvenile salmon fish passage if the drop at low flow exceeds one foot in height (B. Steele, WDFW, pers. comm., 2001). In the mid-1990's, a concrete drop structure was constructed at the bridge crossing to protect against bridge scour. It is this structure that may be hindering passage. However, it is not certain, if at all, to what extent this location may be a partial barrier. In low flow years, spring chinook and migratory bull trout have been observed above the State Hwy. 2 crossing (K. MacDonald and C. Raekes, USFS, pers. comm., 2001)

Chiwaukum Creek. An old log diversion dam, two old pipes, and a water intake box, previously located at RM 0.7, have been removed as of August 2001 (C. Raekes, USFS, pers. comm., 2001). The two pipes had continued to spill water back into Chiwaukum Creek; the status of this diversion is unknown (USFS 1993a).

Chiwaukum Creek. At RM 4.3 there is a natural falls that is a barrier to spring chinook upstream passage (Mullan et al. 1992). Bull trout have been observed above this falls up to another barrier at approximately RM 6.5 (C. Raekes, USFS, pers. comm., 2001).

Skinney Creek (45.0701). At RM 0.25 the culvert under USFS Rd. 7908 acts as a fish passage barrier (USFS Culvert Barrier Database 2000).

Skinney Creek. At RM 1.5 the culvert under USFS Rd. 7909 acts as a fish passage barrier (USFS Culvert Barrier Database 2000).

Skinney Creek. At the time of the writing of this report (August 2001), the three WDOT State Hwy. 2 culverts identified at RM 2.0 (SSHEAR barriers database, January 2001), are being replaced by bottomless box culverts to allow fish passage (C. Belmont, WDOT, pers. comm., 2001).

Skinney Creek. Upstream of the Thomson Creek confluence (approximately RM 2.0), there is a USFS special-use permitted diversion and associated instream pond construction. The pond is located not far upstream from the Winton Mill. The 1995-96 flood damaged the pond and today the pond is no longer functional. When viewed in the summer of 1997 the channel was re-establishing in the bottom of the pond, leaving a 5 ft bare bank, and a 2 ft drop into the pond from the channel upstream. Deep entrenchment and abandoned terraces are a result of downcutting below the pond. The drop into the pond was chute-like over plastic visqueen, and could hamper upstream movement of small fish, but would not be a barrier to adult steelhead (USFS 1999a). A two-inch salmonid was seen below the pond (USFS 1999c).

Skinney Creek. At RM 3.14, there is a beaver pond that backwaters and submerges the culverts under Hwy 2. This was determined by WDOT to not be a fish passage barrier (SSHEAR barriers database, Feb. 7, 2001).

### Screens and Diversions

Chiwaukum Creek. There are several water diversions located on Chiwaukum Creek (USFS 1999c). Information on the location and condition of private water diversions are not available at this time with the exception of what is provided below. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Chiwaukum Creek. An old log diversion dam, two old pipes, and a water intake box, previously located at RM 0.7, have been removed as of August 2001 (C. Raekes, USFS, pers. comm., 2001). The two pipes had continued to spill water back into Chiwaukum Creek; the status of this diversion is unknown (USFS 1993a).

Chiwaukum Creek. At RM 1.5 there is a diversion that does not meet screening criteria (B. Steele, WDFW, pers. comm., 2001).

Skinney Creek. Upstream of the Thomson Creek confluence (approximately RM 2.0), there is a USFS special-use permitted withdrawal and associated instream pond construction. The pond is located not far downstream from the Winton Mill. Damaged sustained to the pond during the 1995-96 flood has led to downcutting of the channel upstream of the pond. Also, there is a 2-foot drop into the pond from the channel upstream, as observed in the summer of 1997 by the USFS. The drop into the pond was chute-like over plastic visqueen, and could hamper upstream movement of small fish, but would not be a barrier to adult steelhead (USFS 1999a). A two-inch salmonid was seen below the pond (USFS 1999a).

The amount of water to be withdrawn and season of use are apparently not specified in the USFS permit (USFS 1999a) and WDOE could not provide information about the withdrawal (USFS 1999a). The permit dates back at least as far as 1962 and was issued in the name of Orville Richards, now deceased (USFS 1999a). A peak flow USGS gaging station operated on Skinny Creek near Winton from 1954 to 1973. Annual peak flow ranged from 6-75 cfs during this period, with typical peak flows in the 30s. Average annual flow in Skinney Creek is likely between 1 and 5 cfs (USFS 1999a).

Improvement of the area is recommended in the USFS Mainstem Wenatchee River Watershed Assessment (1999c) but no specific plans or funding is identified. Should the pond be reconstructed by the permit holder, the forest service should work with the permit holder to ensure steelhead passage. A screen should be installed when water is diverted to ensure that juvenile steelhead and other fish species of concern do not enter the diversion. It is possible that the diversion is not currently in use, in which case no screen may be needed, since the diversion intake may be blocked with a gate when not in use. Summer 1997 photos of the site are available from Dan Rife or Cindy Raekes, Leavenworth Ranger District, Okanogan and Wenatchee National Forest.

### Riparian Condition

Chiwaukum Creek. Some loss of riparian vegetation associated with Tumwater Campground at the mouth and dispersed camping sites located further upstream, have increased streambank erosion locally, however the channel itself has remained relatively stable (USFS 1999c).

Skinney Creek. Overall road density in the watershed is high (3.4 mi./sq. mi.), with a substantial portion of the roads lying in riparian areas (the ratio of riparian road miles to stream miles is 0.5; where riparian road is defined as a section of road within 300 ft of a stream; USFS 1999a).

## Channel Conditions/Dynamics

### Streambank Condition

Chiwaukum Creek. Some loss of riparian vegetation associated with Tumwater Campground at the mouth and dispersed camping sites located further upstream, have increased streambank erosion locally, however the channel itself has remained relatively stable (USFS 1999c).

Skinney Creek. The portions of streambank adjacent to State Hwy. 2 have been stabilized with riprap (B. Steele, WDFW, pers. comm., 2001).

Skinney Creek. Upstream of the Thomson Creek confluence (approximately RM 2.0), not far upstream from the Winton Mill, a permitted irrigation withdrawal and associated pond construction with flood control gates has most likely shaped the type of channel that exists today. Deep entrenchment and abandoned terraces at the pond site (upstream of RM 2.0) are a result of downcutting below the pond. Today the pond is no longer functional and the channel appears to be rebuilding a floodplain through aggradation processes (USFS 1999c).

### Floodplain Connectivity

Chiwaukum Creek. The location of Tumwater Campground at the mouth of Chiwaukum Creek limits the natural migration of the channel over its floodplain and flood control measures have been taken to protect the campground (USFS 1999c).

Skinney Creek. The location of State Highway 2 has reduced the channel's ability to access its floodplain and increased entrenchment (USFS 1999c).

### Width/Depth Ratio

Chiwaukum Creek. No identified concerns of increasing width/depth ratios provided in the literature or by professional knowledge for Chiwaukum Creek. Disturbance to the channel is limited to some disturbance at the mouth associated with the location of the Tumwater Campground and recreation activities at the site.

Skinney Creek. No identified concerns of increasing width/depth ratios provided in the literature or by professional knowledge.

### Entrenchment Ratio

Chiwaukum Creek. No indication of entrenchment concerns provided in the literature or by professional knowledge for Chiwaukum Creek. Disturbance to the channel is limited

to some disturbance at the mouth associated with the location of the Tumwater Campground and recreation activities at the site.

Skinney Creek. The location of State Highway 2 has reduced the channel's ability to access its floodplain and has increased channel entrenchment (USFS 1999c).

Skinney Creek. Upstream of the Thomson Creek confluence (approximately RM 2.0), not far upstream from the Winton Mill, a USFS special use permitted diversion and associated pond construction has most likely shaped the type of channel that exists today. Deep entrenchment and abandoned terraces are a result of downcutting below the pond. Today the pond is no longer functional and the channel appears to be rebuilding a floodplain through aggradation processes (USFS 1999c).

### Habitat Elements

#### Channel Substrate

Chiwaukum Creek. No embeddedness was reported in excess of 35% in all surveyed reaches (mouth to Glacier Creek confluence RM 8.3; USFS 1993a).

#### Large Woody Debris

Chiwaukum Creek. In the lower 0.6 miles, LWD levels are poor (D. Rife, USFS, pers. comm., 2000). LWD levels did not meet Forest Plan Standards in three of four surveyed reaches (USFS 1993a) however, instream LWD and recruitment potential are considered to be within the natural range for the corresponding channel types (Rosgen A2 and B2/3) up to the bull trout migration barrier at RM 6.5 (C. Raekes, USFS, pers. comm., 2001).

Skinney Creek. Impacts related to the construction of the railroad and later State Highway 2 during the early part of the 1900's, combined with agriculture and timber harvest practices, have limited fish habitat by decreasing woody debris input and increasing sediment input (USFS 1999c). Large woody debris abundance is below historic levels (USFS 1999c).

#### Pool Frequency

Chiwaukum Creek. Pools are not common in the first 0.6 river miles of Chiwaukum Creek. which is an alluvial fan (USFS 1993a). Although pool abundance did not meet Forest Plan Standards in all surveyed reaches (USFS 1993a), pool frequency is considered to be within the natural range for the channel types present (Rosgen A2 and B2/3) up to the bull trout barrier at RM 6.5 (C. Raekes, USFS, pers. comm., 2001).

Skinney Creek. In the lower 0.5 miles, pool frequency is fair (D. Rife, USFS, pers. comm., 2000).

### Pool Depth

Chiwaukum Creek. Deep pools are not common in the first 0.6 river miles of Chiwaukum Creek which is an alluvial fan (USFS 1993a). However, pool depth is considered to be within the natural range for Rosgen A2 and B2/3 channel types present in Chiwaukum Creek from RM 0.6 to 6.5 (C. Raekes, USFS, pers. comm., 2001).

Skinney Creek. In the lower 0.5 miles, pool depth is poor (D. Rife, USFS, pers. comm., 2000).

### Off-Channel Habitat

Skinney Creek. The location of State Highway 2 has reduced the channel's ability to access its floodplain and has increased channel entrenchment (USFS 1999c).

Skinney Creek. Upstream of the Thomson Creek confluence (approximately RM 2.0), not far downstream from the Winton Mill, a permitted irrigation withdrawal and associated pond construction with flood control gates has most likely shaped the type of channel that exists today. Deep entrenchment and abandoned terraces are a result of downcutting below the pond. Today the pond is no longer functional and the channel appears to be rebuilding a floodplain through aggradation processes (USFS 1999c).

### Water Quality

#### Temperature

Chiwaukum Creek. Ten excursions beyond the state criterion have placed the creek on the 303(d) list for temperature recordings (WDOE 1998). However, there is presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing. Most of the drainage is contained in federally designated wilderness and the channel has not been greatly exposed to solar radiation as a result of land management practices.

#### Fine Sediment

Skinney Creek. Impacts related to the construction of the railroad and later State Highway 2 during the early part of the 1900's, combined with agriculture and timber harvest practices, have limited fish habitat by decreasing woody debris input and increasing sediment input (USFS 1999c). Fine sediment appears to be high, and may have been historically high due to the natural geomorphology of the area (USFS 1999a).

Skinney Creek. Overall road density in the watershed is high (3.4 mi./sq. mi.), with a substantial portion of the roads lying in riparian areas (the ratio of riparian road miles to

stream miles is 0.5; where riparian road is defined as a section of road within 300 ft of a stream; USFS 1999a).

### Water Quantity

#### Dewatering

Chiwaukum Creek. Chiwaukum Creek has not been observed to dewater in the lower 2.1 miles.

Skinney Creek. Skinney Creek has not been observed to dewater in the lower 0.5 miles.

#### Change in Flow Regime

Chiwaukum Creek Drainage-wide. There are 3 surface water rights permits or certificates worth a potential total diversion of 0.5 cfs. There are 3 surface water rights claims worth a potential total diversion of 0.4 cfs. There are no pending applications for surface water rights, certificates, or claims. There is 1 groundwater rights permit or certificate worth a potential total withdrawal of 50 gpm. There are 2 groundwater rights claims worth a potential total withdrawal of 15 gpm. There are no applications for groundwater rights permits, certificates or claims pending (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Chiwaukum Creek Drainage Fish Distribution and Use. Table 3 describes current, known salmon, steelhead, and bull trout use in the Chiwaukum Creek drainage. Steelhead/rainbow trout and spring chinook are known to spawn and rear in Chiwaukum Creek up to a barrier falls at RM 4.3 (USFS 1999c). Bull trout and spring chinook salmon were observed spawning in Chiwaukum Creek in August and September 2001 (C. Raekes, USFS, pers. comm., 2001). Bull trout have been observed upstream of the RM 4.3 falls barrier, up to the next falls at RM 6.5 (C. Raekes, USFS, pers. comm., 2001).

In Skinney Creek, rainbow/steelhead and spring chinook rearing is known to occur (USFS 1999c) but is restricted to the lower 0.25 miles by an impassable culvert on USFS Rd. 7908. Bull trout are not known to occur in Skinney Creek and given its elevation and geomorphology, the habitat is more optimal for rainbow/steelhead than for bull trout.

Chiwaukum Creek Drainage Summary. The importance of the Chiwaukum Creek drainage lies in its potential contribution to bull trout production, although of concern is the current low numbers of this species in the upper watershed. Maintaining fish passage at the mouth is critical. Anadromy on Chiwaukum Creek is naturally limited by an impassable falls at RM 4.3. Anadromous salmonid use in the drainage is naturally limited by the stream channel morphology to rearing in Chiwaukum and Skinney Creeks,

except for some spawning in the lower 4.3 miles of Chiwaukum Creek. Chiwaukum Creek lies mostly within the Alpine Lakes Wilderness and has, for the most part, not been altered except at the mouth. The campground situated at the mouth of Chiwaukum Creek lies in the alluvial fan and the stream has been channelized restricting channel migration in this reach. Spawning and rearing production in the impacted reach has likely been reduced by the channel alterations. This area supports spring chinook and steelhead spawning and rearing along with limited summer chinook rearing while also serving as a corridor to headwater spawning and rearing habitat for bull trout.

Skinney Creek, the one tributary to Chiwaukum Creek known to support anadromous salmonids (steelhead/rainbow trout anadromy and spring chinook rearing), was severely impacted by the railroad during the first part of the 19<sup>th</sup> century and subsequently, by State Highway 2. Passage into Skinney Creek is blocked by USFS road culverts at RM 0.25 and 1.5. In addition, high overall road density in the watershed with a substantial portion of the roads lying in riparian areas and private land ownership in the stream bottom (with resulting agriculture and timber harvest) has combined to limit fish habitat by decreasing woody debris input, increasing sediment input, and potentially reducing migratory corridors.

### **Beaver Creek Drainage.**

Beaver Creek Drainage Description. This drainage is 6,310 acres in size with elevation ranging from 1,640 feet at the mouth of Beaver Creek to 5,500 feet on Entiat Ridge. Approximately 2,400 acres (38%) were burned in the 1994 Tye wildfire. Precipitation ranges from 25 to 40 inches annually. During glaciation, a thick mantle of glacial till was deposited over the underlying Swauk Sandstone formations. As the mantle eroded, it carried glacial material down into the mainstem of Beaver Creek filling and widening the upper valley. The development of highly erodible sandstone formations overlain by glacial till also created conditions favorable for mass wasting processes. Mass wasting is still common in the headwaters areas, delivering sediment and debris to Beaver Creek. The South Fork Beaver Creek drainage escaped glaciation but is within the Swauk Sandstone area and contributes naturally high levels of fine sediment to the Beaver Creek system. Land is in private ownership from the mouth up to approximately RM 3.0, downstream of S. Fk. Beaver Creek, with USFS ownership in the mid and upper reaches. The private portion is in agriculture (hay fields). Although historic timber harvest and associated road development has had and continues to have a negative impact on salmonid habitat conditions, much of the federal portion is now designated Late-Successional Reserve (LSR) and therefore managed to protect and enhance late-successional Reserves and old-growth forest ecosystems. Beaver Creek enters the Wenatchee River in Plain, Washington at RM 46.2, a few miles below the junction of the Wenatchee and Chiwawa Rivers.

Beaver Creek Drainage Discussion of Hydrogeomorphology and Habitat Conditions. On Beaver Creek, from the mouth to RM 2.5, ten stream crossing structures were identified, six of which were determined to be fish passage barriers (Harza 2000). The first barrier

occurs at RM 0.3. Riparian roads placement/density, riparian harvest, and private development and agriculture within riparian areas have negatively impacted the riparian habitat, LWD recruitment, and channel processes (USFS 1999a). Floodplain development and road construction have resulted in a loss of floodplain area (USFS 1999a). High level of fines, especially in the South Fork Beaver Creek (RM 3.25) and the mainstem Beaver Creek downstream of the South Fork. Roads and harvest units in the drainage contribute to what would be a high background level of fine sediment. Channel simplification along the lower portions of Beaver Creek combined with high road densities and placement within the riparian area likely result in elevated instream temperatures (USFS 1999a).

Beaver Creek Drainage Current Known Habitat Conditions. The following list of information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

#### Access to Spawning and Rearing

##### Obstructions

(natural barriers are also provided here)

Beaver Creek (45.0751). Harza (2000) identified 10 structures (culverts, bridges and dams) in Beaver Creek from RM 0.0 to 2.5 at private or county road crossings. Six of these were determined to be fish passage barriers and passage at one other was unknown. The first barrier occurs at RM 0.3 on Chiwawa Loop Road where two partially crushed culverts create impassable barriers. A diversion dam is located approximately 60 feet downstream from the culverts. Fish passage at the dam is “unknown” (Harza 2000) based on Level A Fish Passage Barrier Assessment criteria (WDFW 1998a). At RM 1.9 there is a culvert at a private drive crossing that is a fish passage barrier . At RM 2.0 there is a culvert at a private crossing and a wooden dam that are both fish passage barriers. The uppermost fish passage barrier structure identified was a culvert at a private crossing at RM 2.5. These barriers are located downstream of USFS managed land.

Beaver Creek. Upstream of RM 2.5, on USFS managed land (not included in the Harza barrier survey) there are two culverts identified in the USFS Year 2000 culvert barriers database (data retrieval date, February 2001). It was not possible to determine whether the first culvert, at RM 3.9, (USFS Road 6103-000), was a fish passage barrier based on USFS barrier criteria. The second culvert, at RM 5.1 (USFS Road 6106-315), was determined not to be a fish passage barrier based on USFS barrier criteria.

Beaver Creek. Mullan et al. (1992) reported several beaver dams acting as barriers to upstream migration beginning at about RM 0.5. During the Harza 2000 fish barrier survey, no beaver dams were identified.

#### Screens and Diversions

Beaver Creek. At RM 0.5 there is an old water diversion structure that does not appear to be in use and is not affecting fish (A. Viola, WDFW, pers. comm., 2000). Bryant and Parkhurst (1950) reported a flow in mid-July of 1937 of 4 cfs in this 8 to 9 foot brushy stream. They reported that the flow was largely used for irrigation and becomes almost dry later in the summer. Mullan et al. (1992) did not comment on irrigation withdrawals and any effect on flow by diversions but did report a flow of 4 cfs.

#### Riparian Condition

Beaver Creek. Riparian road placement, riparian harvest, private development, and agriculture within riparian areas have negatively impacted the riparian habitat (USFS 1999a). The road network associated with historic timber harvest units is extensive and mainly uses riparian areas for corridors thereby reducing floodplain function by confining the stream channel (USFS 1998j).

#### Channel Conditions/Dynamics

##### Streambank Condition

Beaver Creek. Based on degraded riparian and floodplain conditions, streambank conditions are likely fair to poor using the 2496 Habitat Rating Criteria (D. Driscoll, USFS, pers. comm., 2001).

##### Floodplain Connectivity

Beaver Creek. Floodplain development and road construction have resulted in a loss of floodplain area (USFS 1999a).

Beaver Creek. In the mid-to upper-portion of the drainage, the road network associated with historic timber harvest units is extensive and mainly uses riparian areas for corridors thereby reducing floodplain function by confining the stream channel (USFS 1998j).

##### Width/Depth Ratio

No information available.

### Entrenchment Ratio

No information available.

### Habitat Elements

#### Channel Substrate

Beaver Creek. Five Wolman pebble counts conducted in 1995 (USFS 1999a) identified a high level of fines, especially in the South Fork Beaver Creek and mainstem Beaver Creek, downstream of the South Fork. Roads and harvest units in the drainage contribute to what would be a high background level of fine sediment. Several road surfacing projects have occurred in the drainage as well as decommissioning/closure of roads to try to mitigate the problem (USFS 1999a).

#### Large Woody Debris

Beaver Creek. Timber harvest practices and road development have reduced the level of LWD and LWD recruitment in Beaver Creek (USFS 1999a; USFS 1998j).

#### Pool Frequency

Beaver Creek. Reductions in LWD input as a result of timber harvest, road placement and agriculture, and high fine sediment levels contributed in part by roads and harvest units have reduced pool frequency (USFS 1999a; USFS 1998j).

#### Pool Depth

Beaver Creek. Reductions in LWD input as a result of timber harvest, road placement and agriculture, and high fine sediment levels contributed in part by roads and harvest units have reduced pool quality (USFS 1999a).

#### Off-Channel Habitat

Beaver Creek. Development, timber harvest and road construction have negatively impacted off-channel habitat (USFS 1999a). The lower stream reaches are currently managed as hay fields replacing what historically supported riparian habitat, beaver dams and side channel habitat within the floodplain (USFS 1998j).

## Water Quality

### Temperature

Beaver Creek. Development, timber harvest, and channel simplification along the lower portions of Beaver Creek combined with high road densities and placement within the riparian area likely result in elevated instream temperatures (USFS 1999a). However, there is presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing.

### Fine Sediment

Beaver Creek. Five Wolman pebble counts conducted in 1995 (USFS 1999a) identified a high level of fines, especially in the South Fork Beaver Creek and the mainstem Beaver Creek downstream of the South Fork. Roads and harvest units in the drainage contribute to what would be a high background level of fine sediment. Several road surfacing projects have occurred in the drainage as well as decommissioning/closure of roads to try to mitigate the problem (USFS 1999a).

## Water Quantity

### Dewatering

Beaver Creek. There are no documented observations of dewatering in Beaver Creek (D. Rife, USFS, pers. comm., 2000).

### Change in Flow Regime

Beaver Creek. It is likely that peak/base flows have been altered and the drainage network has been increased in Beaver Creek. This is based on concerns regarding harvest units, high road densities (3.5 mi/sq.mi), and road location within 300 feet of the stream (3.9 mi/sq.mi; USFS 1999a).

Beaver Creek. At RM 0.5 there is an old water diversion structure that does not appear to be in use and is not affecting fish (A. Viola, WDFW, pers. comm., 2000). Bryant and Parkhurst (1950) reported a flow in mid-July of 1937 of 4 cfs in this 8 to 9 foot brushy stream. They reported that the flow was largely used for irrigation and becomes almost dry later in the summer. Mullan et al. (1992) did not comment on irrigation withdrawals and any effect on flow by diversions but did report a flow of 4 cfs.

Beaver Creek. Up until the late 1990's, water was diverted from the Miners Corral water diversion on Miners Creek (tributary to the Mad River) on the Entiat subbasin side of the Entiat Ridge, and added to Beaver Creek in the Wenatchee subbasin. In the late 1990's,

the USFS did a Biological Assessment (B.A.) of the impacts of special use permits for irrigation ditch diversions on federal land. The Miner Creek diversion was included in the assessment. It was determined that there was not a water right for the diversion and the water diversion was required to be discontinued. Miners Creek naturally has a very low flow during low flow times of the year (0.9 cfs on 6/20/94, downstream of the 0.57 cfs diversion at Miners Corral).

Beaver Creek Drainage Fish Use and Distribution. Table 3 describes current, known salmon, steelhead, and bull trout use in the Beaver Creek drainage. There is no historic or current information that suggests this stream was ever used by spring chinook salmon. Only one bull trout has been found in Beaver watershed on one occasion in the early 1990s (USFS 1999a). Brook trout were observed in Beaver Creek during fish surveys in 1991. Currently, there are several structures that are barriers to fish passage. The downstream-most fish blocking culvert is located at RM 0.3.

Beaver Creek Drainage Summary. Salmonid production potential exists naturally only for steelhead/rainbow trout in the Beaver Creek drainage. This potential is naturally low due to the limited hydrology and natural channel characteristics of the drainage. Beaver Creek is also in a highly degraded state for most habitat attributes. Most of the existing conditions are due to private development (including agriculture), road placement, and timber harvest activities. Adult passage is impacted by passage barriers as well as water quality and low flow; spawning is impacted by flow, temperature, and sediment, and rearing habitat is negatively impacted by almost every habitat attribute.

## MAINSTEM WENATCHEE RIVER WATERSHED SUMMARY

Habitat conditions in the mainstem Wenatchee River have the greatest potential to affect salmonid fish production in the Mainstem Wenatchee River Watershed and in the Wenatchee River Subbasin as a whole, with the exception of bull trout (K. MacDonald, USFS, pers. comm., 2001). The Wenatchee River serves as the migratory corridor for adult and juvenile salmonids as well as providing essential rearing habitat for steelhead and chinook salmon. Hillman and Chapman (1989a) concluded that total juvenile salmonid densities in the Wenatchee River were primarily limited by the availability of high flow refuge habitat, post-emergence. Protecting and restoring highly diverse habitat that provides refuge during spring runoff from high flows (off-channel habitat) will help lower chinook emigration, post-emergence (Chapman 1989a), from the Wenatchee River. Protecting and restoring highly functional, off-channel habitat will also contribute to improving the river's ability to dissipate energy and reach a more stable equilibrium with ecosystem processes.

As the summer progresses, age-0 chinook and steelhead fry (young-of-the-year) rapidly emigrate from the Wenatchee River (Hillman and Chapman 1989a). Although Hillman and Chapman (1989a) cited other studies that have associated presmolt movements with decreasing flows, temperatures, and surface area, their research on the Wenatchee River showed no strong relationship among salmonid emigration, decreasing temperatures or

surface area. Instead, they suggest biotic factors such as intra-specific interaction for available habitat, presmolt releases of hatchery chinook salmon, nocturnal sculpin predation, and redbreast shiner interaction may accelerate age-0 chinook salmon and steelhead emigration. Hillman and Chapman concluded that the rapid loss of salmon fry observed during early summer may be the result of fry densities that exceeded the river's late summer rearing capacity. Being able to associate the quantity of suitable summer and early fall rearing habitat available at various flows would enable land managers to more closely predict the benefits of increasing flows, improving habitat diversity, or taking no action in a reach. Until this level of detail is made available, 1) protecting and restoring habitat complexity and channel function and 2) improving summer and early fall instream flows have the greatest potential to improve the rearing capacity of the mainstem Wenatchee River.

The mainstem Wenatchee River also provides overwintering habitat for juvenile spring chinook and juvenile steelhead. Hillman and Chapman (1989a) were unable to show a relationship between steelhead emigration and declining temperatures in the Wenatchee River from data collected during 1986 and 1987. This is probably because the Wenatchee River contained plenty of suitable winter habitat (Chapman et al. 1994b) during those years. It is likely, however, that juvenile steelhead emigrate from smaller tributaries with the onset of colder stream temperatures (Chapman et al. 1994b), emphasizing the importance of maintaining adequate winter rearing habitat in the mainstem Wenatchee River. With declining stream temperatures ( $<10^{\circ}\text{C}/50^{\circ}\text{F}$ ) both juvenile spring chinook and steelhead selected deeper water and larger substrates (Hillman and Chapman 1989c). During winter days in the Wenatchee River when stream temperatures remained below  $10^{\circ}\text{C}$  ( $50^{\circ}\text{F}$ ), juveniles remain concealed in the substrate, mostly in pockets among boulder armor along stream banks (Hillman and Chapman 1989b). During winter nights, juveniles emerge from cover and lay on small and large boulders adjacent to their daytime cover. There was very little upstream or downstream movement (Hillman and Chapman 1989c). Most pools used by juvenile steelhead and salmon in the Wenatchee River are ice covered during winter months. In pools where warmer groundwater influenced temperatures, both species selected nighttime stations in them (Hillman and Chapman 1989c).

Derby Canyon Creek and Beaver Creek have very little potential to contribute or negatively impact anadromous salmonid production in the Mainstem Wenatchee River Watershed or the Wenatchee River subbasin as a whole. They lack the natural hydrology and the size. The importance of the Chiwaukum lies in its potential to contribute to bull trout production in the Wenatchee Subbasin. The Chiwaukum Creek drainage, mostly unimpacted by human land-use except at the mouth where the campground is in the alluvial fan and the stream has been channelized, probably historically had good production for spawning and rearing spring chinook and steelhead and limited summer chinook rearing. The bigger concerns here though are why bull trout numbers are so low in the Chiwaukum Creek drainage and maintaining/rehabilitating habitat conditions at the mouth to pass bull trout into the upper Chiwaukum (K. MacDonald, USFS, pers. comm., 2000).

## MAINSTEM WENATCHEE RIVER WATERSHED DATA GAPS

- Location of functioning riparian and floodplain habitat and condition within the channel migration zone of the Wenatchee River.
- Analysis of relationship between stream flows and habitat quantity on the Wenatchee River from Tumwater Canyon downstream to the mouth..
- Analysis of stream flow effects on temperature in the mainstem Wenatchee River.
- The effect high water temperatures on anadromous salmonids and bull trout migration, spawning, incubation, and rearing in the mainstem Wenatchee River.
- Extent to which road densities and placement affect sediment delivery and channel function in Chumstick Creek (UCRTT 2001).
- Stream channel migration study of the Chumstick Creek corridor.
- Cumulative effects of water withdrawals and diversions on salmonid habitat conditions in Chumstick Creek (UCRTT 2001).

## MAINSTEM WENATCHEE RIVER WATERSHED PROJECT RECOMMENDATIONS

- Stream Channel Migration Study of the Wenatchee River.
- Identify flood-prone areas of the lower Wenatchee River, particularly from the Mission Creek confluence (RM 10.4) downstream to the Columbia River confluence (MCMCP 1998). This should be captured in a stream channel migration study. Identify selected sites where floodplain access can be reestablished through passive restoration.
- Identify, protect and restore high-flow refugia habitat (side channels) in the Wenatchee River corridor. This should be captured in a stream channel migration study.
- Provide year-round passage to and from the wetlands that were cut off from the lower Wenatchee River because of Highway 2 placement, from Fairview Canyon (RM 7.2) downstream to Sleepy Hollow bridge (RM 3.5; MCMCP 1998).
- Increase late summer instream flows in the Lower Wenatchee River area.
- Identify and maintain highly functioning, summer and early fall rearing habitat in the Wenatchee River corridor. Identification of this habitat should be captured in a stream channel migration study.

- Identify and restore summer and early fall rearing habitat in the Wenatchee River corridor. Identification of habitat in need of restoration should be captured in a stream channel migration study.
- Identify and protect highly functional riparian habitat in the Wenatchee River corridor. Identification of this habitat should be captured in a stream channel migration study.
- Investigate alternatives and feasibility of alternatives for increasing instream flows in the Lower Wenatchee River area.
- Develop riparian habitats on the lower Wenatchee in the right-of-ways along State Highway 2 (MCMCP 1998).
- Protect selected sites along the mainstem Wenatchee River, from the mouth of Lake Wenatchee downstream to Deadhorse Canyon (RM 37.0). This reach is important spawning habitat for ocean-type chinook salmon, and overwinter habitat for numerous life history types. Recruitment of LWD into the stream channel in this reach should be encouraged (MCMCP 1998).
- Implement water conservation measures that return saved water to instream uses.
- Develop a water bank/trust.
- Monitor camper impacts to fish passage during low flows, from damming of the stream for wading pools during low flow years.
- Restore full fish passage at the North Road culvert on Chumstick Creek (RM 0.3) to allow unimpeded upstream passage for salmonids (MCMCP 1998).
- Restore full fish passage at stream crossings upstream of the North Road culvert on Chumstick Creek to allow unimpeded fish passage while minimizing channel constrictions. This should be done in a comprehensive, coordinated strategy.
- Protect floodplain and riparian habitat in the Chumstick drainage, including off-channel habitat.
- Reduce sources of human-induced sediment delivery to the Chumstick Creek channel.
- Increase late-summer flows in Chumstick Creek (MCMCP 1998).
- Restore degraded riparian habitat on Chumstick Creek (MCMCP 1998).
- Improve water quality on Chumstick Creek (MCMCP 1998).

## MISSION CREEK WATERSHED

### *Mission Creek Watershed Description*

The Mission Creek watershed is a 93 square mile (59,609 acres) drainage in north central Washington, approximately 10 miles west of the city of Wenatchee. Mission Creek is the main stream course in the watershed, flowing 9.4 miles (Mullan et al. 1992) before emptying into the Wenatchee River (RM 10.4) at the town of Cashmere. This relatively narrow (approximately 6 miles wide) drainage trends in a north-south direction, with the eastern ridge defining the edge of the Columbia River Breaks. Elevations range from 795 feet at Cashmere at the mouth of the drainage to 6,887 feet near Mission Peak in the headwaters. Seventy-eight percent of the watershed is managed by the USFS (53,052 acres; Mullan et al. 1992) and the remaining 22 % is privately owned.

Mean annual precipitation in the Mission Creek watershed ranges from 15 inches near Cashmere to 35 inches in the upper elevations (CCCD 1996). The average annual precipitation is 19 inches with the Mission Creek watershed contributing only 1% of the average annual flow of the Wenatchee River (WDOE 1982). In this environment, the majority of the channels in the watershed are intermittent and flow water during spring runoff/snow melt, quickly becoming dry by the middle to end of June. Three main perennial tributaries to Mission Creek are Brender, Yaksum and Sand creeks (CCCD 1996). Brender Creek enters Mission Creek at RM 0.2 within the town of Cashmere, just upstream of the mouth of Mission Creek, draining the lower elevation areas to the west of Mission Creek. Yaksum Creek enters Mission Creek at RM 1.9 draining the lower elevation areas east of Mission Creek. Sand Creek enters Mission Creek at RM 7.5 (Mullan et al. 1992) directly above the irrigated lands, draining the middle portion of the watershed to the east of Mission Creek, including the Camas Lands.

Although permanent Native American settlement of the watershed was limited because of more favorable conditions closer to the Wenatchee River, mining opportunities in the greater Wenatchee subbasin drew Euro-humans to the area in the mid-1800's. By 1855, miners had established a settlement at the mouth of Mission Creek. Significant agricultural settlement in the watershed began around 1900 and led to the rapid development of all lowland acres conducive to agriculture (CCCD 1996). By the mid-1930's, most accessible timber had been harvested in the drainage, fueled by the growing economy; a 1938 Soil Conservation Service (SCS) analysis indicated the entire Mission Creek drainage was being overcut (CCCD 1996). Timber harvest activities continued in the watershed from 1940 until the early 1980's, especially intensive on privately-owned corporate timber lands. Overall, 17% percent of the watershed has been logged (Mullan et al. 1992). Grazing has also contributed to habitat degradation in the watershed (Mullan et al. 1992). Prior to 1925, records indicate that most of the drainage was overgrazed and some of it in rather serious condition (CCCD 1996). Also of concern in the watershed are the potential impacts on the aquatic habitat from catastrophic fire. After 60 years of fire suppression in the watershed, the USFS believes there is an increasing risk of catastrophic fire that could result in additional erosion, loss of shade cover on streams, and lack of LWD for stream channels (USFS 1999d).

## *Mission Creek Watershed Discussion of Hydrogeomorphology and Habitat Conditions*

The topography of the Mission Creek watershed is characterized by extremely steep slopes, dissected by deeply incised perennial and intermittent stream channels. The geologic and soil features of the watershed landtypes create stream flow regimes with flashy runoff with little late summer recharge potential (USFS 1995c) except within the larger alluvial deposits along the valley floor (CCCD 1996). Brender and Mission Creeks historically flowed through a large, flat wetland area that had a profusion of beaver dams and marshes prior to emptying into the Wenatchee River (NRCS 1996). Wet meadows in valley bottoms act as important storage areas regulating base flows.

Geology and land forms in the watershed exhibit a strong effect on flow characteristics. During volcanic fissure eruptions in the Columbia basin, lava was introduced into cracks within the sandstone rocks, resulting in basalt rock fragments interspersed throughout the sandstone formations. At the head of Mission Creek, lava flows also covered portions of sandstone formations, later fracturing and opening cracks that allow water from snow melt and rain to penetrate deep within the formations. Given the complex structure of the sandstones and volcanics, ground water movement and surface water exchange can be difficult to predict without data collection and analysis (Montgomery Water Group et al. 1995; CCCD 1996). This applies to the unknown effects of the many domestic wells in use in the alluvium in the Mission Creek valley. Most of these private domestic wells are shallow (<30 feet), with a few being <5 feet total depth (CCCD 1996).

Complicating the understanding of flow characteristics in the Mission Creek watershed are the diversions of surface waters from Mission Creek, the influence of irrigation waters conveyed from Icicle and Peshastin creeks and spilled into Mission and Brender Creeks (CCCD 1996), and the alteration of the hydrology of Mission, Brender and Yaksum Creeks by land use activities. Mission Creek has been observed to run dry downstream of Sand Creek (Hindes 1994) and shallow wells along Mission Creek have also been known to run dry during summers with little or no rainfall (CCCD 1996). Bryant and Parkhurst (1950) reported 13 unscreened irrigation diversions taking the entire flow during irrigation season a short distance above its mouth. Historic records indicated Brender Creek ran dry during the late summer months (CCCD 1996; NRCS Inventory and Analysis 1996), however currently, there is year-round flow in Brender Creek downstream of approximately RM 4.0 during irrigation season because of Peshastin Irrigation District return flows into Brender Creek (B. Steele, WDFW, pers. comm., 2001). Yaksum Creek is also reported to go dry for portions of the summer (CCCD 1996). Although there are no reports of Sand Creek going dry, it has a recorded low flow of <1 cfs (Mullan et al. 1992). Low water levels act as a passage barrier to migrating adult spring chinook salmon, juvenile steelhead/rainbow, and juvenile spring chinook salmon in the Mission Creek watershed; passage of migrating adult steelhead trout may also be hindered in low water years. Irrigation diversion dam structures, and culverts also may impede fish passage for migrating adult spring chinook, juvenile salmonids, and in some years, migrating adult steelhead and (NRCS 1996; MCMCP 1998; USFS 1999d). Minimum flows were established in WAC 173.545.030 for Mission Creek near Cashmere at RM 1.5.

Soils in the watershed are generally derived from the highly erodible and unstable sandstone formations (CCCD 1996). The Devils Gulch (RM 10.3) area and the middle reach of Little Camas Creek (a tributary to Sand Creek) provide good examples of the drainage's sandstone geology. In these areas, steep sandstone bluffs with exposed bedrock or a thin mantle of soil covering bedrock are evident. The drainages are significant producers of sediment for the channel network and affect downstream reaches (CCCD 1996). In the uplands, runoff rates are medium to very rapid, depending on the steepness of the slope, with most runoff occurring during severe rainstorms and rain-on-snow events (CCCD 1996). Valley soils, being composed of sandstone, shale, and occasional igneous rocks washed from higher elevations, are generally more permeable unless human activities have resulted in soil compaction. However, soil erosion rates during severe rainstorms and periods of rapid snow melt can still be severe in the valley soils as well, depending on slopes and degree of soil compaction (CCCD 1996).

The majority of the channels within the watershed are stable and steep, with entrenched to moderately entrenched channels (Rosgen A and B type channels) that are unlikely to change laterally, but will change vertically (incise) depending on the timing and amount of sediment inputs (USFS 1998h). Some channels, like the East Fork of Mission Creek and the mainstem of Mission Creek, would possibly have been slightly entrenched, meandering, alluvial channels (Rosgen C type channels) prior to the effects of road confinements (USFS 1998h) and flood control measures. In a watershed that already has naturally high erosion rates and frequent mud/debris flows from Devils Gulch area (also natural), human activities that result in accelerated erosion rates and delivery to streams, reduced LWD, and channel confinements, exacerbate an already fragile system. Intensive grazing, timber harvest, road development, and loss of floodplain function through development and flood control, have combined to make the Mission Creek the most human-impacted watershed in the Wenatchee subbasin (Mullan et al. 1992). These land use impacts have altered the hydrology of Mission, Brender and Yaksum creeks to varying degrees (CCCD 1996; NRCS 1996).

Local concerns over flood damage and deteriorating conditions in the watershed resulted in several watershed restoration efforts in Mission, Brender and Yaksum creeks prior to the 1990s. These efforts resulted in a variety of improvements in watershed condition. However, some earlier in-channel restoration work involved removal of beaver, debris clearing, and channelization (Mullan et al. 1992), which removed the water retention/energy dissipation structure in the channel system. This work, combined with road-related channel confinement and increased sediment loading, has resulted in downcutting, floodplain abandonment and probably contributed to a reduction in baseflows (USFS 1995h). It has also increased the destructive potential during flood events (NRCS 1996). In the cropland and urbanized areas, the stream alterations are more dramatic with the mainstems of Brender, Yaksum, and particularly Mission Creek having changed considerably when compared to a hundred years ago (NRCS 1996). Mission Creek from the USFS boundary (RM 8.0) to the mouth is also on the State Water Quality 303(d) list for DDT, DDE, fecal coliform, and dissolved oxygen (WDOE 1998). Mission Creek is rated as the most polluted waterbody in the Wenatchee River system by the Wenatchee River Watershed Ranking Project (Hindes 1994).

*Mission Creek Watershed Current Known Habitat Conditions.*

The following list of information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

Access to Spawning and Rearing

Obstructions

(natural barriers are also provided here)

Mission Creek (45.0089). Access to upper Mission Creek and its tributaries is poor due to dewatering of lower Mission Creek near the City of Cashmere. Low water levels act as a passage barrier to spring chinook salmon and may hinder passage of migrating adult steelhead trout at times (USFS 1999d).

Mission Creek. At RM 1.0 (within the Cashmere city limits), in 1995 there was a rock dam that was a barrier to fish passage at low flows. At higher flows adults could pass. It is unknown whether this rock dam still exists (B. Steele, WDFW, pers. comm., 2001). It was not listed in the Harza fish passage barrier inventory (2001).

Mission Creek. From Pioneer Street (RM 1.1) upstream to the Yaksum Creek confluence at RM 1.9, the stream channel dewater during irrigation season creating a fish passage barrier (B. Steele, WDFW, pers. comm., 2001).

Mission Creek. There is an irrigation diversion at RM 6.0 referred to as the Miller Diversion (B. Steele, WDFW, pers. comm., 2001; Hinde 1994). It is reported by B. Steele (WDFW, pers. comm., 2001) to be a full fish passage barrier. Hinde (1994) reported the channel had been observed to dewater downstream of the Miller water diversion (Hinde 1994). The extent of dewatering was not described by Hinde.

Mission Creek. At RM 7.4, three side-by-side culverts may create a fish passage barrier. It was not possible to determine with confidence whether or not the culverts at this location were fish passage barriers given the level of evaluation funded (Harza 2000).

Mission Creek. At RM 8.0 there is an unauthorized water diversion dam. There are also many more wooden water control structures at various locations within the channel which were designed and installed in 1990 by the USFS, to create pools and build floodplain.

These structures may create fish passage problems at certain flows (B. Steele, WDFW, pers. comm., 2001).

Mission Creek. There are at least 10 private irrigation diversion pumps with associated diversion dams located on Mission Creek. More specific locations are not readily available. The majority of the irrigation dams are impassable for juvenile fish and several would also prevent adult passage. At least some of the irrigation pumps are not properly screened (NRCS 1996). The status of the diversions and screens associated with the surface water rights are unknown at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001). Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

Brender Creek (45.0090). At RM 0.2, the Kimber Road culvert is identified as a barrier to fish passage (Harza 2000). However, steelhead and spring chinook juveniles are reported to occur upstream of RM 0.2, to RM 0.7 at the Evergreen Road concrete flume (NRCS 1996; B. Steele, WDFW, pers. comm., 2001).

Brender Creek. At RM 0.7, at the outlet of the Evergreen Road culvert, there is a steep concrete “flume” that carries the entire flow of the creek for about 100 feet. The stream then drops 4 feet off the end of this flume blocking all upstream fish movement (Harza 2000).

Brender Creek. The Evergreen Road culvert at RM 0.7 is a barrier to fish passage (Harza 2000). Although several resident rainbow adult trout were found at the outlet of the Evergreen Road culvert just above the flume, no fish of any species were located upstream of this culvert (NRCS 1996; Harza 2000).

Brender Creek. From the Evergreen Road culvert fish passage barrier (RM 0.7) upstream to RM 3.8, sixteen culverts, one flume, and two water diversion dams were identified as fish passage barriers (Harza 2000). Most of the culverts are undersized for the types of flows associated with Brender creek. The result is higher velocity flows that impede upstream passage of fish, especially juveniles (Harza 2000).

Yaksum Creek (45.0100). At the confluence of Yaksum and Mission creeks, there is a small fall with no plunge pool that at low flows could prevent passage of juvenile salmonids into Yaksum Creek to rear (Harza 2000). The lower 0.1 miles of Yaksum Creek have been straightened and no longer meanders within the floodplain at the Mission Creek confluence, but now cascades steeply into Mission Creek (NRCS 1996).

Yaksum Creek. The channel immediately above the small falls at the mouth dewater for a very short distance (<45 feet). There is also a culvert that acts as a fish passage barrier culvert immediately above the mouth of Yaksum Creek (Harza 2000). Continuing upstream from the culvert barrier to RM 1.6 there are 8 additional culverts and one dam that create fish passage barriers (Harza 2000).

Sand Creek (45.0135). Culverts at RM 1.0 and 1.29 are identified as fish passage barriers (USFS Culvert Barriers database, Yr. 2000). The USFS is currently designing projects to address these specific culverts (D. Driscoll, USFS, pers. comm., 2001). Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

Little Camas Creek (45.0143). At the mouth of Little Camas Creek, and at RM 0.8 there are culverts that are barriers to fish passage (USFS Culvert Barriers Database 2000). The USFS is currently designing projects to address these specific culverts (D. Driscoll, USFS, pers. comm., 2001). Using the USFS culvert inventory criteria, it was not possible to determine whether the next culvert at RM 3.1 is a fish passage barrier (USFS Culvert Barriers Database 2000). Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

East Fork Mission Creek. Beginning at RM 0.9 and continuing to RM 6.9, the USFS has identified 8 culverts under FS Rd. 7100. Seven of the culverts are identified as fish passage barriers (USFS Culvert Barrier Database 2000) beginning with the culvert at RM 0.9. The uppermost known fish-blocking culvert is at RM 4.3. Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

#### Screens and Diversions

*NOTE:* Information on the location and condition of private water diversions are not available at this time other than what is presented below. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Mission Creek. There is an irrigation diversion at RM 6.0 referred to as the Miller Diversion (B. Steele, WDFW, pers. comm., 2001; Hinds 1994). It is reported by B. Steele (WDFW, pers. comm., 2001) to be a full fish passage barrier. No information regarding its screening condition is available at this time.

Mission Creek. At RM 8.0 there is an unauthorized water diversion dam (B. Steele, WDFW, pers. comm., 2001). In 1996, NRCS reported there were at least 10 private irrigation diversion pumps with associated diversion dams located on Mission Creek (NRCS 1996). More specific information on their locations was not provided. The majority of the irrigation dams were reported to be impassable for juvenile fish and several were described as also preventing adult passage. At least some of the irrigation pumps were said to not be properly screened (NRCS 1996). The status of the diversions and screens associated with the surface water rights are unknown at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### Riparian Condition

Mission, Brender and Yaksum Creeks. Below the USFS National Forest boundary (RM 8.0), land use practices have drastically altered the natural stream channels. Within the confines of the town of Cashmere, the stream channels are highly confined by light industrial/urban/suburban development. Upstream of the town of Cashmere, suburban/rural/agricultural development has altered the natural stream channel. On Mission Creek in some stream reaches, riparian habitat in the naturally narrowing valley has been completely converted to orchards, pasture or hay production with at best a thin band of cottonwood/shrubs adjacent to the confined channel (Andonaegui, C., WCC, pers. observation, 2001). Conversion of riparian habitat to urban/rural/residential development, overgrazing, and agriculture encroachment on the floodplain are the major negative influences on riparian conditions. For example, the dominant plant community on the lower 1.6 miles of Yaksum Creek is reed canarygrass (NRCS 1996). In the past few years, some revegetation projects have been initiated near the mouth of Mission, Brender and Yaksum creeks within the town of Cashmere. Although riparian habitat is good in some locations, more riparian habitat restoration work is needed (B. Steele, WDFW, pers. comm., 2001).

Mission Creek. County Road 11 and USFS Road 7100, closely parallel the lower 17.0 miles of the creek, reducing streamside vegetation. The riparian zone along the stream banks is narrow, quickly giving way upslope to dry ponderosa pine vegetation types. Mature trees are lacking within the riparian zone, which is currently vegetated by alder and other shrub species. Timber harvest, road building, agricultural encroachment and urban development have greatly reduced the natural vegetation, especially any large conifers that might have occurred near the stream side (USFS 1999d).

Brender Creek. Upstream of the USFS boundary (RM 3.0) the riparian habitat is in "Fair" condition (D. Rife, USFS, pers. comm., 2000).

Yaksum Creek. The first 1500 feet of Yaksum Creek upstream from the mouth is highly altered and entrenched; the remaining 1.6 miles of lower Yaksum Creek have been

converted to a roadside ditch with some piping. The dominant vegetative cover is reed canarygrass (NRCS 1996).

Sand Creek. The USFS Road 7104 closely parallels the creek from the mouth upstream to the Little Camas Creek confluence (RM 1.7). This has reduced riparian vegetation along the stream (USFS 1999d). Timber harvest has also occurred in the riparian zone up to RM 4.1, which naturally is very narrow (approximately 50 feet wide; USFS 1993b).

Little Camas Creek. Little Camas Creek has been manipulated by management activity within the riparian area along all its reaches (USFS 1999b).

East Fork Mission Creek. Riparian areas have been highly modified by road constraints and logging (USFS 1991b). The USFS Roads 7100 and 7102 are almost entirely located within the floodplain, reducing the amount of riparian vegetation in the lower 5.3 miles (USFS 1999d). Recent logging activity has occurred in the riparian areas within the floodplain (USFS 1991b).

#### Channel Conditions/Dynamics

##### Streambank Condition

Mission, Brender and Yaksum Creeks. After the 1930 floods, the lower stream reaches were channelized, riprapped, and had log revetments installed to artificially maintain their position within the floodplain. This flood protection work was expanded in the 1950's (USFS 1995c; NRCS 1996).

Mission Creek. Channel constriction resulting from development within the floodplain of Mission Creek and its tributaries has resulted in bank erosion and downcutting (incision) of the channel (USFS 1999d). Woody riparian vegetation is mostly limited to a single band of trees, shrubs or grasses, and at times replaced by orchard or hay production. The banks, however, are generally stable at this time both within the town of Cashmere and in the upstream reaches located in agricultural areas, with the exception of a head cut between RM 7.0 and 10.0, that has initiated as a result of channel manipulations (B. Steele, WDFW, pers. comm., 2001). Bank stabilization efforts and channel incision appears to be containing recent flow conditions pending a channel-changing event resulting from high flows and/or sediment pulses. There is no LWD present, recruitment is extremely low, and generally LWD is removed for flood control and safety purposes.

Brender Creek. The channel has been straightened and forced into several right-angle turns below the concrete flume just downstream of Evergreen Road (RM 0.1). Sand depositions in this lower reach have altered the channel flow, which now flows under Sunset Highway and is then culverted through most of its length through the Mill site (NRCS 1996).

Brender Creek. There is a headcut and associated bank erosion near the 7200 block of Pioneer Street (NRCS 1996). However, bank stabilization efforts, channel incision, a lack of LWD, and the lack of recent channel changing events, have resulted in overall stable banks presently.

Yaksum Creek. The first 1500 feet of Yaksum Creek upstream from the mouth is highly altered and entrenched; the remaining 1.6 miles of lower Yaksum Creek have been converted to a roadside ditch with some piping. The dominant vegetative cover is reed canarygrass (NRCS 1996).

Sand and E. Fk. Mission Creeks. Presently, stream banks are vegetated with lots of brushy vegetation and there is no reported streambank instability under current conditions (USFS 1991b; USFS 1993b). However, the degraded riparian zone and the artificial channel confinement by roads put streambank stability at risk for erosion given a high flow, channel changing event.

### Floodplain Connectivity

Mission Creek. Channel constriction from USFS Roads 7100, 7101, 7102, 7104, County Road 11 and many other private and spur roads being placed with the floodplain of Mission Creek and the majority of its tributaries, has reduced the accessible floodplain of Mission Creek by 50 percent (USFS 1999d). The County road parallels the lower 10.7 miles of Mission Creek and then USFS Road 7100 for the next 6.3 miles (USFS 1999d).

Mission Creek. Encroachment into the floodplain by urban/residential development, agriculture, and flood control practices (i.e. berming, channelization, LWD removal) have reduced floodplain function (B. Steele, WDFW, pers. comm., 2001). At the confluence of Mission Creek and the Wenatchee River, the floodplain has been highly altered by the placement of fill, channelization, riprap, and the construction of a railroad grade. Buildings, graded lots, and roads have been constructed in the immediate vicinity of the Mission Creek/Wenatchee River confluence (Andonaegui, C., WCC, pers. observation, 2001).

Mission Creek. Floodplain function in the vicinity of the Brender and Yaksum creek confluences with Mission Creek has been impaired by conversion of riparian and floodplain habitat to road and residential development (Andonaegui, C., WCC, pers. observation, 2001).

Brender Creek. The channel upstream of Evergreen Road (RM 0.66) has been channelized, is downcutting, and has numerous fish passage problems (NRCS 1996).

Brender Creek. Upstream of the USFS boundary (RM 3.0) floodplain connectivity is in "Fair" condition (D. Rife, USFS, pers. comm., 2000).

Yaksum Creek. The lower 0.1 miles of Yaksum Creek is highly altered and entrenched. It no longer meanders within the floodplain at the Mission Creek confluence, but now cascades steeply into Mission Creek, creating a fish passage barrier for juveniles (NRCS 1996). The remaining 1.6 miles of lower Yaksum Creek have been converted to a roadside ditch with some piping. The dominant vegetative cover is reed canarygrass (NRCS 1996).

Sand Creek. Although the floodplain is naturally narrow, it has been impacted by the USFS Rd. 7104 (USFS 1993b).

Little Camas Creek. Floodplain connectivity is “Fair” for Little Camas Creek (D. Rife, USFS, pers. comm., 2000).

East Fork Mission Creek. The USFS Roads 7100 and 7102 are almost entirely located within the floodplain along the lower 5.3 miles of the creek (USFS 1999d).

#### Width/Depth Ratio

Mission, Brender and Yaksum Creeks. No identified concerns of increasing width/depth ratios provided in the literature or by professional knowledge, however for RM 10.3 – 15.7 of Mission Creek there is a data gap for this attribute.

#### Entrenchment Ratio

Mission, Brender and Yaksum Creeks. Channel incision has occurred as a result of channel confinement from road placement, urban/residential development, and agricultural conversion within the floodplain and channel migration zone (USFS 1995c; NRCS 1996; USFS 1999d). Within the town of Cashmere urban and residential roads cross the stream channels multiple times, constraining the channels. Outside of the city limits, the Mission Creek county road, which turns into USFS Rd. 7100, parallels Mission Creek up to its headwaters, constructed almost entirely within the floodplain where floodplain exists. Additionally, dredging, channelization, and lack of LWD, has resulted in a single main channel for each stream characterized by a uniform bed. Flows become very shallow in these simplified channels during low flow periods where naturally there was functioning floodplain and riparian habitat (B. Steele, WDFW, pers. comm., 2001).

Brender Creek. Two headcuts have been identified; one behind the cemetery and a very large head cut and bank erosion site near the 7200 block of Pioneer Street, by the apartment complex at the intersection of Pioneer and Wohlers streets. Brender Creek has been channelized in this reach (NRCS 1996).

Sand Creek. Entrenchment ratio is “Fair” for Sand Creek (USFS 1993b).

East Fork Mission Creek. Road impacts and naturally erosive soils are contributing to channel downcutting in East Fork Mission Creek (USFS 1991b; D. Rife, USFS, pers. comm., 2000).

### Habitat Elements

#### Channel Substrate

Mission Creek. Given the highly erosive soils found throughout the watershed, there is naturally a high rate of sediment delivery from tributaries and a resultant high level of fines (sand) in depositional reaches of Mission Creek. However, following stream channelization, berming in the floodplain, riparian habitat removal, drastic decrease in LWD recruitment, LWD cleanouts, and bank stabilization, the sediment transport regime has been altered and channel complexity has decreased. The result is channel incision in some reaches of lower Mission Creek with heavy sediment deposition in low gradient reaches.

Sand and E. Fk. Mission Creek. Given the highly erosive soils in the drainages, there is naturally a high rate of sediment delivery to stream channels. Combined with habitat impacts like channel confinement, riparian habitat degradation, and lack of LWD, the result is channel incision in some reaches of Sand and E. Fk. Mission creeks, with heavy sediment deposition in low gradient reaches (USFS 1991b; USFS 1993b).

#### Large Woody Debris

Mission and Brender Creeks. Large woody debris within the lower reaches has been removed for flood control (USFS 1995c; NRCS 1996). Recruitment of LWD from riparian zones within the lower stream reaches has declined as a result of agricultural and residential riparian zone encroachment. Stream channelization and some stream side roading are also contributing factors (USFS 1995c; USFS 1999d). Residential development occurring up to the streams' banks, bank stabilization efforts, and loss or drastic reduction of riparian habitat associated with residential development further limit instream LWD (C. Andonaegui, WCC, pers. observation, 2001).

Yaksum Creek. The first 1500 feet of Yaksum Creek is highly altered and entrenched; the remaining 1.6 miles of lower Yaksum Creek have been converted to a roadside ditch with some piping. The dominant vegetative cover is reed canarygrass (NRCS 1996).

Mission, Sand, Little Camas, and East Fork Mission Creeks. On USFS lands, timber harvest and road construction within the riparian zone have reduced the potential for LWD recruitment (USFS 1995c) and LWD levels in-channel are severely lacking (USFS 1999d).

### Pool Frequency

Mission, Sand, Little Camas, and East Fork Mission Creeks. Currently, timber harvest and roads have decreased the amount of LWD, decreased the natural sinuosity of the creeks, and increased fine sediment, reducing the number of pools (USFS 1999d). Although there is naturally a high level of fines (sand) in depositional reaches of these streams, the sediment transport regime has been altered by human impacts, decreasing channel complexity. The result is exacerbating sediment deposition in low gradient reaches.

Mission Creek. Downstream of the USFS boundary (RM 8.0), there are very few pools. Most pools are associated with private irrigation diversion dams and managed to provide adequate water depths at the point of diversion (NRCS 1996). These pools do not provide the instream structure components that support quality juvenile rearing habitat (i.e. undercut banks, root wads, overhanging vegetation, LWD). The diversion dams themselves are generally composed of local streambed cobbles and boulders, scrap lumber, sheet metal and broken concrete, and layers of Visqueen or canvas. They are generally not sustainable through high flow events, leaving rearing juveniles without refuge and contributing pulses of sand and silt to downstream areas (NRCS 1996).

Brender Creek. Two headcuts have been identified; one behind the cemetery and a very large head cut and bank erosion site near the 7200 block of Pioneer Street, by the apartment complex at the intersection of Pioneer and Wohlers streets. Brender Creek has been channelized in this reach (NRCS 1996). From the mouth upstream to RM 3.0, channelization has converted the streambed to a flat, uniform bed lacking complexity (B. Steele, WDFW, pers. comm., 2001).

Yaksum Creek. The first 1500 feet of Yaksum Creek is highly altered and entrenched; the remaining 1.6 miles of lower Yaksum Creek have been converted to a roadside ditch with some piping.

### Pool Depth

Mission, Sand, Little Camas, and East Fork Mission Creeks. Currently, timber harvest and roads have decreased the amount of LWD, decreased the natural sinuosity of the creeks, and increased fine sediment, reducing the number of pools with depths greater than 3 feet. Pools are typically shallow and sandy and average about one foot deep. (USFS 1999d). Although there is naturally a high level of fines (sand) in depositional reaches of these streams, the sediment transport regime has been altered by human impacts, decreasing channel complexity. The result is exacerbating sediment deposition in low gradient reaches.

Brender Creek. No deep pools were located in the portion of Brender Creek located on private lands (RM 0.0 – 3.0; NRCS 1996).

Yaksum Creek. The first 1500 feet of Yaksum Creek is highly altered and entrenched; the remaining 1.6 miles of lower Yaksum Creek have been converted to a roadside ditch with some piping.

#### Off-Channel Habitat

Mission, Sand, Little Camas, and East Fork Mission Creeks. Off-channel habitat is lacking due to the influence of the road system and channel degradation (incision) that has resulted in the channels becoming disconnected from their floodplains (USFS 1999d). No wetlands or oxbow habitat was noted during USFS stream surveys and side channels were low to negligible. Old “oxbow” sections and stranded river beds are evident within the floodplain (USFS 1999d).

Brender Creek. From aerial photos (no date on photos referenced), it appears that the historic channel of Brender Creek may have been much shorter, emptying into the Wenatchee River (rather than Mission Creek), which probably flowed along the toe of the hill where the lower portion of Brender Creek now runs behind the mill site. Whether or not it entered the Wenatchee River, it probably flowed through a large, flat wetland area that had a profusion of beaver dams and marshes, and which is now occupied by the mill and wood waste fill (NRCS 1996).

Yaksum Creek. The lower 0.1 miles of Yaksum Creek is highly altered and entrenched. It no longer meanders within the floodplain at the Mission Creek confluence, but now cascades steeply into Mission Creek, creating a fish passage barrier for juveniles (NRCS 1996). The remaining 1.6 miles of lower Yaksum Creek have been converted to a roadside ditch with some piping. The dominant vegetative cover is reed canarygrass (NRCS 1996).

#### Water Quality

##### Temperature

Mission Creek. Instream temperatures recorded by the Chelan County Conservation District (Hindes 1994; CCCD 1999) 750 feet from the mouth of Mission Creek in 1993 and 2000 exceeded properly functioning stream temperature conditions for salmonids of 10–14 °C (16.2 °C on 8/16/93; 15.8 °C on 7/10/00; 21.6 °C on 8/7/00). Although stream temperatures in the Mission Creek watershed tend to be naturally elevated during the summer months given the climate and physical characteristics of the watershed (D. Driscoll, USFS, pers. comm., 2001), elevated stream temperatures in this reach of Mission Creek, which is heavily impacted by land management activities and water diversions, are related to channel impacts and habitat degradation (B. Steele, WDFW, pers. comm., 2001). This is attributed primarily to low flows during the summer, but also to the lack of riparian shading, and the severe modification of the channel (USFS 1999d).

Mission Creek. The CCCD also collected water temperature data in 1992/1993 from one other site on Mission Creek, located 3.6 miles upstream from the intersection of Mission Creek Road and Pioneer Avenue. During 1999/2000 the CCCD operated eight water quality monitoring sites on Mission Creek, collecting temperature data as well as other water quality data (Hindes 1994; CCCD 1999).

The USFS also has recorded periodic instream temperatures on Mission Creek. Based on USFS data, Mission Creek is on the State 303(d) list for numerous excursions beyond State Water Quality standards for high instream temperature at the USFS boundary (RM 8.0; WDOE 1998).

Instream temperature data and recording locations for the CCCD and USFS data have not been compiled into a single database and map coverage making this data difficult to present and analyze for this report. In general, instream temperatures are reported to exceed state and USFS National Forest water quality standards both below and above the USFS boundary (USFS 1999d). It is the opinion of the USFS that stream temperatures in the Mission Creek watershed tend to be naturally elevated during the summer months given the climate and physical characteristics of the watershed. Evidence for this is the higher than standard temperatures that occur in unmanaged headwater locations like Devil's Gulch (D. Driscoll, USFS, pers. comm., 2001). However, elevated stream temperatures in areas heavily impacted by land management activities and water diversions may be related to channel impacts and habitat degradation (B. Steele, WDFW, pers. comm., 2001). This is attributed primarily to low flows during the summer, but also to the lack of riparian shading, and the severe modification of the channel (USFS 1999d). In less impacted stream reaches however, there is presently not enough data to determine if instream temperatures are significantly different than temperatures in the historic range or to what extent these temperatures might negatively impact salmonid migration, spawning, incubation or rearing. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Brender Creek. The CCCD collected water temperature recording from October 1992 to September 1993 at one site on Brender Creek located at the mouth of Brender Creek. Instream temperatures exceeded properly functioning conditions twice during 1992/1993; on 7/19/93 at 14.4 °C; and on 8/16/93 at 15.3 °C (Hindes 1994). The CCCD monitored instream temperatures at four sites from October 1999 to September 2000, including the site at the mouth of Brender Creek monitored in 1992/1993. During this period, instream temperatures exceeded properly functioning conditions for salmonids (10 –14 °C) at all four sites during the month of August (CCCD 1999). Given the alterations to Brender Creek, including irrigation return flows, water diversions, and channelization impacts, elevated instream temperatures may be related to channel impacts and habitat degradation (B. Steele, WDFW, pers. comm., 2001). However, given the limited temperature data, it is difficult to determine the extent to which current water temperatures are significantly different than temperatures in the historic range. This data gap should be addressed in the

Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Sand Creek. The CCCD collected water temperature recording from October 1999 to September 2000 at one site on Sand Creek located just upstream of the USFS boundary (RM 0.25; Hindes 1994; CCCD 1999). The highest water temperature recorded was 12.8 °C on 8/7/00. This is within the range for “Good” (properly functioning) for instream temperatures supporting salmonids, however, one year of data is not adequate to determine whether or not high water temperature may be a concern for Sand Creek.

### Fine Sediment

Mission and Sand Creeks. Natural sediment levels in the watershed are high, however, based on data from McNeil Core sampling, fine sediment levels have increased beyond normal, expected levels to where sediment is no longer in equilibrium for the system. This is attributed to the increase of roads, grazing, timber harvest, and development within the drainages (USFS 1999d).

Mission Creek. Analysis suggests there is a net erosion of Total Suspended Solids (TSS) from the upper portion of the watershed and net deposition in the lower portion of the watershed, with the relative balance being determined by stream flow intensity (Peryea 1997).

Mission, Sand, Little Camas, and East Fork Mission Creeks. Currently, timber harvest and roads have decreased the amount of LWD, decreased the natural sinuosity of the creeks, and increased fine sediment (USFS 1999d). Although there is naturally a high level of fines (sand) in depositional reaches of these streams, the sediment transport regime has been altered by human impacts, decreasing channel complexity. The result is exacerbating sediment deposition in low gradient reaches.

### Water Quantity

#### Dewatering

Watershed-wide. The majority of the channels in the watershed are naturally intermittent and flow water during spring runoff/snow melt, quickly becoming dry by the middle to end of June. This condition is exacerbated by surface water diversions, ground water withdrawals, and irrigation water returns as they occur in the watershed. Information on water diversion, water withdrawals and surface water/ground water interactions is complex and not fully understood in the watershed. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Mission Creek. Mission Creek dewateres from the Yaksum Creek confluence (RM 1.9) downstream to Pioneer Street (B. Steele, WDFW, pers. comm., 2001).

Mission Creek. Dewatering has been observed downstream of the Miller water diversion (RM 6.0; Hinder 1994).

Brender Creek. Historically, Brender Creek has a record of dryness during the late summer months (CCCD 1996). However, currently there is year-round flow in Brender Creek during irrigation season because the Peshastin Irrigation District uses Brender Creek as an irrigation conduit (B. Steele, WDFW, pers. comm., 2001). The discharge into Brender Creek occurs at the intersection of Pioneer and Wohlers streets through a 22-inch diameter culvert. The NRCS Inventory and Analysis Report (1996) states there is evidently a year-round flow from the confluence of Brisky Canyon (RM 4.3) downstream to the mouth.

Brender Creek. At RM 4.0, where there is a culvert crossing at an orchard, Brender Creek goes dry every year about July (pers. comm. with landowner during the 2000 culvert inventory, cited in Harza 2000 database).

Yaksum Creek. The channel immediately above the small falls at the confluence of Mission and Yaksum creeks dewater for a very short distance upstream (<45 feet; Harza 2000).

Yaksum Creek. Yaksum Creek is reported to dewater for portions of the summer (CCCD 1996). The source does not indicate which reaches of the creek dewater.

### Change in Flow Regime

Mission Creek Watershed-wide. There are 5 surface water rights permits or certificates worth a potential total diversion of 1.6 cfs. There are 24 surface water rights claims worth a potential total diversion of 8.5 cfs. There is 1 pending application for a surface water rights permit, certificate, or claim worth 1.0 cfs. There are 16 groundwater rights permits or certificates worth a potential total withdrawal of 1,302 gpm. There are 42 groundwater rights claims worth a potential total withdrawal of 2,556 gpm. There are 2 applications pending for groundwater rights permits, certificates or claims worth a potential total of 250 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Mission Creek Watershed-wide. The hydrology of the watershed has been altered to some degree by tree removal, road building, home building, grazing, and soil compaction. Some of these activities have resulted in faster, more intense runoff during storm events and annual snowmelt (NRCS 1996). Mission Creek is listed on the Washington State 303(d) list for instream flows (WDOE 1998). Base flows have also been reduced by the removal of beaver, the loss of LWD through channel “cleanouts”

done by the Civilian Conservation Corp (CCC), the Soil Conservation Service (SCS, now the NRCS), and the USFS (1935 – 1937 and 1954 – 1959) and channelization from road-related channel confinement. Base flows are also interrupted at times in the late summer at irrigation diversions (USFS 1999d).

Mission Creek. Operational spills with water diverted from Icicle Creek are delivered into Mission Creek by the Icicle Irrigation District (CCCD 1996) at about RM 1.2 (M. Rickel, CCCD, pers. comm., 2001). The influence of the spill provides somewhat of a stabilizing flow for Mission Creek below RM 1.2, although at a very low flow (0.25 cfs) was recorded by CCCD on August 7, 2000 at about RM 0.1 (M. Rickel, CCCD, pers. comm., 2001).

Brender Creek. Spills into Brender Creek with water diverted from Peshastin Creek by the Peshastin Irrigation District system to irrigate agriculture lands along Brender Creek, seasonally influence creek flows (CCCD 1996). The discharge occurs at the intersection of Pioneer and Wohlers streets through a 22-inch diameter culvert. There is evidence of bank erosion, probably from the sudden flush of added flow (NRCS 1996). Road densities in some portions of Brender Creek are as high as 3.69 miles/square mile (USFS 1999d).

Yaksum Creek. The first 1500 feet of Yaksum Creek is highly altered and entrenched; the remaining 1.6 miles of lower Yaksum Creek have been converted to a roadside ditch with some piping. The dominant vegetative cover is reed canarygrass (NRCS 1996).

Sand Creek. Half of the Sand Creek drainage has been harvested, mostly on private land (USFS 1999d). The effect of the harvest on peak and base flows has not been analyzed.

#### *Mission Creek Watershed Fish Use and Distribution*

Historically, spring chinook, steelhead/rainbow, and coho spawned and reared in the Mission Creek watershed. NRCS (1996) speculates that Brender Creek “would have most likely supported” bull trout from the mouth upstream to at least Brisky Canyon (RM 4.0) and that bull trout would have spawned in the very farthest upstream part of the creek with all age classes probably traveling back and forth to the Wenatchee River. Steelhead were likely the more populous anadromous species spawning in the system, however coho may also have been more abundant than spring chinook before coho were extirpated from the region (MCMCP 1998). Spawning spring chinook would have been attracted primarily to Mission Creek, the tributaries being somewhat small for adult spring chinook (NRCS 1996). Currently, Mission Creek has the fewest salmon and steelhead of all the watersheds in the Wenatchee subbasin and given the present conditions, has the least potential to support additional salmonids (CCCD 1996). Table 4 below, describes current, known salmon, steelhead, and bull trout use within the Mission Creek watershed. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 4: Current, known salmon, steelhead, and bull trout use in the Mission Creek Watershed**

Mission Creek Watershed	Spring Chinook			Summer Chinook			Steelhead/Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Mission Creek		X	X		X		X	X	X						
Brender Creek		X					X	X							
Yaksum Creek (no fish present)															
Sand Creek							X	X							
Little Camas Creek								X							
E. Fk. Mission Creek								X							

Currently, no spring chinook spawning occurs in the Mission Creek watershed (Bob Steele, WDFW, M. Rickel, CCCD, and K. MacDonald, USFS, pers. comm., 2001). Spring chinook rearing does occur in Mission Creek from the mouth upstream to RM 1.2 where the Icicle Irrigation District returns flows taken from Icicle Creek to irrigate lands in the Mission Creek watershed (Bob Steele, WDFW and M. Rickel, CCCD, pers. comm., 2001). Currently, neither spring chinook adults nor juveniles are being observed in Mission Creek upstream of the USFS boundary at RM 8.0 (K. MacDonald, USFS, pers. comm., 2001; USFS 1999d).

Spring chinook rearing occurs in Brender Creek up to the concrete flume fish passage barrier located immediately downstream of Evergreen Road at RM 0.7 (B. Steele, WDFW, pers. comm., 2001). Juvenile chinook were also reported in the NRCS Inventory and Analysis Report (1996), and by M. Rickel (CCCD, pers. comm., 2001) to occur in Brender Creek up to RM 0.4 although the observations do not distinguish between spring or summer chinook or indicate what time of year the juvenile chinook were observed. Juveniles of both species of chinook occur in the Wenatchee subbasin from about April through October and are indistinguishable by observation alone. Juvenile chinook observed during this period could be summer chinook, which may pull into the mouth of Mission Creek to rear (NRCS 1996; K. MacDonald, USFS, pers. comm., 2001), whereas juvenile chinook observed during the winter months after summer chinook have exited the Wenatchee subbasin to begin seaward migration, would be spring chinook (MCMCP 1998).

Small numbers of steelhead have been observed spawning in Brender Creek (B. Steele, WDFW, pers. comm., 2000), Mission Creek, and Sand Creek (MacDonald et al. 2000). Steelhead/rainbow trout are known to rear in Mission Creek from the mouth upstream to Devils Gulch (RM 10.3). The “pure” Devils Gulch rainbow/redband population found in the upper Mission Creek watershed may indicate the Mission Creek steelhead are a native stock (MacDonald et al. 2000). The Mid-Columbia Mainstem Conservation Plan, (MCMCP 1998) reported that juvenile steelhead/rainbow trout also overwinter in lower Mission and Brender Creeks where passage is not precluded by low flows or barriers. A passage barrier at the mouth of Yaksum Creek (small fall with no plunge pool) prevents passage of juveniles into Yaksum Creek to rear. Steelhead/rainbow juveniles also rear in E. Fork Mission Creek and Little Camas Creek (a tributary to Sand Creek; TAC 2000). There is no evidence of bull trout currently occurring in the watershed (USFS 1999d) and brook trout have been located upper Mission Creek, lower King Canyon and E. Fk. Mission Creek (CCCD 1996).

### *Mission Creek Watershed Summary*

Cumulative disruption of both stream channel and upland habitat throughout the watershed, except in the Devils Gulch reach of Mission Creek, has resulted in a declining population of spring chinook and steelhead in the watershed since the mid-1880's (USFS 1999d). The most immediate factor contributing to this decline is dewatering, low flows, and the associated high instream temperatures in Mission Creek below Sand Creek. These conditions are believed to prevent or significantly impede migrating adult spring chinook from accessing spawning grounds in the watershed (USFS 1999d). These conditions also may result in direct mortality from stranding, to juvenile chinook and steelhead rearing in the lower reaches of Mission Creek. Low flows and dewatering are also reducing the amount of available rearing habitat in these areas and access to available rearing habitat elsewhere in the watershed. Until flow conditions and water quality concerns can be addressed, other salmonid habitat projects should be delayed.

Secondly, the loss of functioning habitat in the floodplain of Mission and Brender Creeks significantly reduces the salmonid production potential of the watershed. The lower reaches of these streams historically would have been very productive in their natural condition, providing critical overwinter habitat for rearing juvenile salmonids in the Wenatchee subbasin, as well as a migration corridor, spawning habitat, spring high flow refugia for rearing juveniles and adult resting habitat (Hindes 1994; NRCS 1996). A severe loss of floodplain and riparian habitat functions has occurred as a result of channel alterations to accommodate roads, urban and residential development, and agriculture. These alterations have resulted in a channelized stream within the floodplain and have eliminated or reduced woody riparian vegetation to a narrow band of mostly shrubs and with some mature trees. The straightened channel is disconnected from its floodplain and does not allow for habitat forming processes. This transformed stream system is extremely unstable and conditions are worsened by the high sediment loads that move through the system and soil compaction associated with timber harvest and agricultural activities (NRCS 1996). Along with responding to opportunities to reestablish floodplain function, restoring upland habitat that has been impacted by harvest and road

development is necessary to restore stream channel functions in Mission Creek and its tributaries.

Finally, fish passage barriers created by water diversion dam structures and culverts, beginning at the lower end of the watershed on Mission Creek and progressing upstream in the drainage, significantly reduce access to the remaining spawning and rearing habitat.

#### *Mission Creek Watershed Data Gaps*

- Compilation and analysis of water quality data.
- Instream water use and surface water/ground water interactions.

#### *Mission Creek Watershed Project Recommendations*

- Identify and implement measures to increase low flows in lower Mission and Brender Creeks during summer/fall low flow periods.
- Restore floodplain and riparian habitat functions to Mission and Brender creeks.
- Reduce sediment delivery to streams and increase Mission Creek's ability to dissipate energy and manage sediment loads as per the priorities discussed in the habitat restoration section of the Draft Upper Columbia Salmon Recovery Board Strategy (UCRTT 2001).
- Restore fish passage in lower Mission and Brender Creeks.
- Analyze the relationship between human- induced impacts and elevated instream temperatures.

### PESHASTIN CREEK WATERSHED

#### *Peshastin Creek Watershed Description*

Peshastin Creek is a tributary to the Wenatchee River, originating at Blewett Pass and flowing in a northeasterly direction 15.4 miles (Mullan et al. 1992) before entering the Wenatchee River at RM 17.9 , downstream of the town of Peshastin. Elevations range from 9,470 feet at Mt. Stuart to 967 feet at the mouth (Mullan et al. 1992). The Peshastin Creek watershed encompasses 78,780 acres of which the USFS owns 82% (64,600 acres), 29% (18,734 acres) of which are managed as wilderness. The remaining 18% of the watershed (14,180 acres) is in private ownership (Mullan et al. 1992) with the majority of that (10,000 acres) owned by Long View Fibre Company (USFS 1998f). Logging has occurred on 18% of the watershed (Mullan et al. 1992) with some drainages experiencing extensive overall harvest (USFS 1999f).

There are 14 tributaries entering Peshastin Creek and three lakes with a total surface area of 26 acres. Peshastin Creek, while one of the major watersheds in the Wenatchee subbasin as far as size, contributes only 4% of the low flow for the Wenatchee River (Hindes 1994). As one moves downstream through the Wenatchee subbasin from the cascades crest to the Columbia River, annual precipitation levels decrease. The Peshastin Creek watershed, situated in the lower portion of the subbasin, is a more arid watershed, with annual precipitation levels ranging from 80 inches in the upper elevations to 15 inches at the mouth of Peshastin Creek (USFS 1999f; Hindes 1994). The major tributaries include Mill (RM 5.2), Camas (RM 6.2), Ingalls (RM 9.4), Ruby (RM 10.5), Negro (RM 11.1), Tronsen (14.9), Shaser (RM 15.5), and Scotty (RM 16.6) creeks with most of the watershed's discharge coming from Ingalls Creek (65%; USFS 1999f). Ingalls Creek originates near Mount Stewart with most of the drainage located within the Alpine Wilderness. The second largest contributor of flow to Peshastin Creek is Negro Creek (33-50%; USFS 1999f). Negro Creek originates near Navaho and Miller Peaks. No portion of this drainage is designated wilderness although it does lie almost entirely within USFS boundaries. There are numerous water diversions on Peshastin Creek, all privately owned except for one on lower Peshastin Creek at RM 4.8, which is operated by the Peshastin Irrigation District (PID; USFS 1999f). The diversion dam for the PID is located downstream at RM 2.4. Peshastin Creek has very low late summer flows and high instream temperatures.

State Highway 97 parallels Peshastin Creek for most of its length from RM 0.64 at the State Highway 2 bridge crossing to RM 13.7, before turning to follow Tronsen Creek, one of Peshastin Creek's major tributaries, to Swauk Pass. Placer mining for gold caused disruption to the channel from 1860 to 1940 but declined in the mid-1900's. Small scale operations using sluicing, dredging, and panning techniques still occur in the watershed and is regulated for the protection of fish by the Washington Department of Fish and Wildlife (WDFW). In the lower portion of the watershed there is significant urban, residential and agricultural encroachment on stream channels (Hindes 1994). Recreation is currently the main activity in the Peshastin Creek watershed with the Ingalls Creek drainage experiencing the heaviest use (USFS 1999f). Activities include hunting, fishing, hiking, camping, horseback riding, suction dredge mining, climbing, snowmobiling, and cross country skiing.

#### *Peshastin Creek Watershed Discussion of Hydrogeomorphology and Habitat Conditions*

The Peshastin Watershed is an area of complex geology. The majority of the watershed is composed of Swauk Sandstone, except Ingalls and Upper Blewett areas which have granite origin. Slopes range from low gradient areas (>3%) like lower Peshastin Creek and Camas Meadows, to moderate slopes on much of the east side of the drainage to very steep slopes on the west side. There is a high natural surface erosion and related sedimentation level in the watershed. Surface erosion, which is the dominant process, is punctuated by mass wasting (USFS 1999f). Valley morphology for Peshastin Creek varies from open and meandering to sharply incised and bedrock controlled. Tributary channels are dominated by steep slopes and "V" shaped valleys (USFS 1999f). The USFS Peshastin Watershed Assessment (1999f) provides a very detailed discussion of

channel geomorphological characteristics and habitat impacts by stream reach for Peshastin Creek and its tributaries.

The north end of the watershed (the watershed drains from south to north) contains most of the intermittent stream channels and is steeper, dryer and sparsely forested compared to the south end of the watershed. Slopes are sharply dissected by dry draws which feed into incised, intermittent channels. Northern exposures are forested, while southern exposures are steep with large expanses of exposed sandstone at higher elevations. Channel bottoms are somewhat well vegetated with shrubs and some trees. Large wood is present but limited due to the scarcity of trees on southern exposures. The vegetation and large woody debris in and adjacent to these channels is critical for minimizing water velocities when water does flow in them. The dry channels have high flows of considerable energy during rain-on-snow events or intense summer rains. These events also carry a considerable amount of bedload. Stream widths are 4 to 6 feet. Surrounding slopes are between 40% and 70% and steeper at high elevations (USFS 1999f).

The Peshastin Creek watershed has a long history of Euro-human impacts beginning in the mid-1800's with placer mining for gold. By the late 1880's/early 1900's, the bottom lands of lower Peshastin Creek were already logged off and conversion to agriculture was underway (USFS 1999f). Today, the Peshastin Creek watershed is in a checkerboard ownership of federal and private land from its mouth to its headwaters. Most private holdings in the headwaters area, upstream of Tronsen Creek (RM 14.9), are owned by Longview Fibre and heavily roaded and logged from multiple entries (USFS 1999f). Below the Ingalls Creek confluence (RM 9.4), the Peshastin Creek corridor is exclusively in private ownership (Cappellini 1998) and largely converted to residential use and orchards. Conversion of portions of the channel meander zone and floodplain to agricultural and residential use have contributed to the loss of floodplain functions through channel confinement (dikes, roads, bank protection) and channel constrictions (culverts, diversion dams, bridge structures), and loss of riparian functions such as instream temperature regulation and LWD recruitment. Extensive overall harvest throughout much of the watershed, including upland and riparian logging, high road densities, and the location of roads in riparian areas, have resulted in a decrease in LWD recruitment potential and increased sedimentation and sediment delivery to streams.

The construction of State Highway 97 in 1956 has had a very significant negative impact on Peshastin Creek, by reconstructing 19,317 feet of stream channel. The reconstruction straightened meander bends, reducing the total channel length of Peshastin Creek by 0.8 miles, from the mouth upstream to just downstream of the confluence with Tronsen Creek at RM 14.9 (USFS 1999f). The location of the highway also forced the abandonment of 34% (194 acres) of the total acres of floodplain (565 acres) along Peshastin Creek in this same reach (USFS 1999f). Road densities throughout the watershed are high (>2.4 miles/square mile) except in the Ingalls Creek drainage (USFS 1998f), an artifact of management activities aimed at timber harvest. There is some ongoing timber harvest on both Forest Service and Longview Fibre lands.

Water use has also had a significant affect on aquatic habitat and stream function, contributing to low flows or dewatering and elevated instream temperatures in some reaches, affecting sediment and LWD transport through the system, and fish passage. The Peshastin Irrigation District operates a water diversion dam and diversion on Peshastin Creek at RM's 2.4 and 4.8, respectively (USFS 1999f). The diversion dam at RM 2.4 partially blocks spring chinook salmon migration, depending on flows, and fully blocks bull trout migration from mid-June to October during mid- to low-flows. During late summer, in years when total water diversion exceeds instream low flows, the area directly downstream of the diversion is dewatered for 100 feet (USFS 1998f; Cappellini 1998). The extent and duration of dewatering varies depending on climatic conditions (USFS 1999f). At RM 1.0 where the Chelan County Conservation District measured flows from September 1992 through October 1993, a low flow of 0.3 cfs was reported on September 27, 1993 (Hindes 1994). There are also numerous individual, private irrigation diversions operating along Peshastin Creek and its tributaries, including one on Mill Creek, 0.13 miles upstream of the mouth (USFS 1999f). Mill Creek is the largest tributary to Peshastin Creek below RM 6.0 and the only perennial tributary below RM 6.0 (USFS 1999f), contributing a flow of approximately 1-2 cfs (Peshastin Creek flow was recorded at 8.5 cfs in July 1992; USFS 1999f).

Past mining activities that have affected stream function in the watershed include placement of mine tailing piles adjacent to streams affecting channel morphology, channel reconstruction/straightening, removal of riparian vegetation for access, suction dredging, and damming. Regarding current impacts, Scotty Creek has probably seen the most impact from mining in the entire Peshastin Watershed, with some mining claims still active on its tributaries (USFS 1999f). Specifically, suction dredging can have a significant negative effect on salmonid production by modifying habitat through the removal of woody debris, the movement and rearrangement of substrates, and contribution of fine sediment to the stream (USFS 1998f).

#### *Peshastin Creek Watershed Current Known Habitat Conditions*

The following list of information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

## Access to Spawning and Rearing

### Obstructions

(natural barriers are also provided here)

Peshastin Creek (45.0232). At RM 2.4, the Peshastin Irrigation District operates a water diversion dam on the eastside of the creek. The water diversion itself is located on the west side of the creek at about RM 4.8. The diversion dam presents a barrier to summer and fall migration (mid June through October) partially blocking migrating spring chinook salmon, and migrating bull trout. It also precludes the movement of resident rainbows from the lower drainage into cooler waters of the upper watershed. During late summer, in years when total water diversion exceeds instream low flows, the area directly downstream of the diversion is dewatered for 100 feet, completely blocking all fish passage (USFS 1998i; USFS 1998f).

Mill Creek (45.0245). There were remnants of a water diversion dam about 330' upstream from the mouth of Mill Creek (USFS 1990a). It did not appear to be affecting flows when observed in 1990. It is unknown presently whether this diversion is active, is a fish passage barrier, or whether the dam is ever reworked.

Mill Creek. At RM 1.0, a culvert on Mountain Ranch Road is a barrier to fish passage (Harza/Bioanalysts 2000). Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an "impassable" culvert given the "right" conditions, in some years.

Mill Creek. At RM 2.3, where FS Rd. 7300 crosses Mill Creek the second time, there is a culvert that may be a fish passage barrier.

Hansel Creek (45.0265). The USFS Culvert Barriers Data (2000 survey) identifies fish passage culvert barriers at RM 0.9 and 1.5 on USFS Rd. 7310.

Ingalls Creek (45.0273). At RM 9.8 there is a natural falls that is a barrier to upstream fish passage (Ringel 1997a).

Ruby Creek (45.0318). There are three fish blocking culverts identified in the lower 1.48 miles of Ruby Creek all located on USFS Road 7204 (USFS Culvert Barriers database, Yr. 2000). The first fish passage barrier is identified as a culvert at RM 0.04. The second barrier is a culvert at RM 0.64. The uppermost fish blocking culvert identified in the USFS database is at RM 1.48 and corresponds to the uppermost extent of known steelhead trout distribution identified by Dan Rife (USFS, pers. comm., 2000). Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed

the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

Negro Creek (45.0323). At RM 2.9 there is a 7 foot natural falls that is a barrier to upstream fish passage (Ringel 1997a).

Tronsen Creek (45.0346). On Tronsen Creek, seven culverts are identified as fish passage barriers; three on State Hwy. 97 crossings, two on Tronsen Campground Road, and two on USFS Rd. 7360 (SSHEAR Fish Passage Barrier Database 2000; USFS Culvert Barriers database Yr. 2000). Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

Tronsen Creek (45.0346). At RM 5.9 and 7.0, Hwy 97 culvert crossings are barriers to fish passage (SSHEAR Fish Passage Barrier Database 2000).

N. Fork Shaser Creek (45.0365). At RM 1.7 just upstream of the confluence, there is a 5’ natural falls.

N. Fork Shaser Creek. The USFS Culvert Barriers Data (2000 survey) identifies a fish passage culvert barrier at RM 2.24 on USFS Rd. 7322..

Middle Fork Shaser Creek (45.0366). The USFS Culvert Barriers Data (2000 survey) identifies a fish passage culvert barrier at Milepost 1.0 on USFS Road 7322-200. Known steelhead occurrence upstream of fish barrier culverts can usually be attributed to the potential for certain individual adult steelhead trout which are strong swimmers to exceed the average ability and pass through an “impassable” culvert given the “right” conditions, in some years.

Scotty Creek (45.0376). At RM 1.6, a Longview Fibre culvert is identified as a fish passage barrier (Harza 2000).

### Screens and Diversions

*NOTE:* Information on the location and condition of private water diversions are not available at this time. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Peshastin Creek. The Peshastin Irrigation District (PID) water diversion is located at RM 4.8. It is screened appropriately.

Peshastin Creek. The Tandy irrigation ditch is located upstream of the PID diversion about one-half mile. It is unknown whether the diversion is currently being used or what the condition of the diversion is (B. Steele, WDFW, pers. comm., 2001).

Unnamed tributaries (45.0233, 45.0234, 45.0235, 45.0236) to Lower Peshastin Creek. Unnamed tributaries entering Peshastin Creek at RMs 1.4 (right bank), 2.25 (left bank), 3.0 (left bank), and 3.3 (left bank) all have irrigation diversions (USFS 1999f). The tributaries are all intermittent and primarily steep (mostly 8-20% gradient) transport type channels, naturally limiting salmonid fish distribution. However, diversion dams limit the potential to transport wood, sediment, water, and nutrients during spring run-off and winter and summer storm events (USFS 1999f), thereby negatively affecting habitat function and quality in downstream portions of the watershed. The status and location of the diversions and screens are unknown at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Mill Creek. There were remnants of a water diversion dam about 330' upstream from the mouth of Mill Creek (USFS 1990). It did not appear to be affecting flows when observed in 1990. It is unknown presently whether this diversion is active or whether the dam is ever reworked.

Mill Creek. Approximately 770' upstream from the mouth of Mill Creek there is a diversion dam (USFS 1999f). The 1990 USFS stream survey reported the dam was maintained and the diversion in use. Presently, no additional information is available regarding the maintenance or use.

Mill Creek. There is a private irrigation diversion structure located at approximately RM 0.8 (USFS 1990). It was reported to be influencing mid- and late-summer flows (USFS 1999f). No additional information is available.

### *Riparian Condition*

Peshastin Creek. From the mouth upstream to just below the Ingalls Creek confluence (RM 9.0), conversion of riparian habitat to residential/urban, rural and agricultural use has heavily impacted riparian habitat. Overall, the riparian zone is reduced in size, continuity, species composition, and successional stages. Where woody riparian vegetation exists, it is mostly composed of a shrub/seedling inner zone with an immature tree overstory/grass and forb understory outer zone. (Cappellini 1998)

Peshastin Creek. From RM 14.1 upstream, the drainage is in checkerboard ownership with most private holdings owned by Longview Fibre. Many roads are located within riparian habitat and the uplands are heavily roaded/logged from multiple entries for timber harvest. The USFS reports that riparian vegetation upstream of RM 14.1 is mainly reduced to shrub species as a result of timber harvest (USFS 1999f). However Dean

Priebe (Longview Fibre, Interoffice Memo providing comments to the 4/20/01 draft Wenatchee Salmonid Habitat Limiting Factors Report) commented that “even where clearcuts have been done to the edge or across Peshastin Creek, young trees are growing” and that although “shrubs may dominate in isolated areas, the majority of the riparian is filled with trees”.

Mill Creek. Road development and timber harvest within riparian areas have negatively impacted riparian habitat (USFS 1999f).

Hansel Creek (45.0265). The lower mile was cut heavily in 1975 leaving no riparian buffers (USFS 1999f). Sometime after 1975 the USFS began harvesting in the headwaters of Hansel Creek which resulted in clearcutting and increased roading. Additional entries were made between 1986 and 1992 in the headwaters on USFS land. Riparian habitat is dominated by alder and other shrub species (USFS 1999f).

Ruby Creek. The riparian areas of the drainage have been impacted by mining activities and past timber harvest practices which included tractor use and skidding down tributary draws as a common practice (USFS 1999f). Mining activities have reduced streamside vegetation and LWD recruitment. The USFS Rd. 7304 parallels the entire lower 1.5 miles of Ruby Creek within 100’ of the channel. Presently, the lower portion of the stream channel is heavily vegetated with early successional species, however, it may be missing a large conifers component (D. Driscoll, USFS, pers. comm., 2001).

Negro Creek. Past mining impacts have affected the morphology of the stream (USFS 1999f). Large piles of mine tailings have forced the stream energy into channel banks and established side channels (USFS 1999f). Mining activity has also resulted in a reduction in LWD inputs to the stream; floodplain disturbance from roads and mining camps which, due to the valley morphology, are generally within 40 feet of the creek; and erosion from hydraulic mining scars, some of which have never revegetated (USFS 1999f).

Tronsen Creek (45.0346). Past timber harvest and the impacts of State Hwy. 97 are negatively impacting stream conditions (D. Driscoll, USFS, pers. comm., 2001). Hwy. 97 parallels the stream from RM 0.0 – 9.2; the stream is 12 miles long. Canopy cover is low, especially in the lower few miles (USFS 1992b).

Shaser Creek (45.0347). Road development and mining activities have greatly reduced riparian zone and floodplain functions (USFS 1992a).

North Fork Shaser Creek. Timber harvest impacts are much like the Middle Fork of Shaser Creek, with numerous roads in the riparian areas and intensive timber harvest activities (USFS 1999f). In 1992, riparian roads and riparian harvest had reduced canopy cover; clearcut and broadcast burning have been done extensively although no broadcast burning has been done on Longview Fibre lands. In addition, depositional areas are visible where streamside vegetation is clearcut on both banks (USFS 1999f).

Middle Fork Shaser Creek. Many roads are located within riparian habitat confining the stream, reducing vegetation and shade and LWD input (USFS 1999f). The uplands are heavily roaded/logged from multiple timber harvest entries (USFS 1999f).

Scotty Creek. Many roads are located within riparian habitat with the uplands heavily roaded/logged from multiple timber harvest entries. Riparian vegetation in this portion of Peshastin Creek is mainly reduced to shrub species as a result of timber harvest (USFS 1999f). However Dean Priebe (Longview Fibre, Interoffice Memo providing comments to the 4/20/01 draft Wenatchee Salmonid Habitat Limiting Factors Report) commented that “even where clearcuts have been done to the edge or across the stream, young trees are growing” and that although “shrubs may dominate in isolated areas, the majority of the riparian is filled with trees”.

Scotty Creek. This drainage has probably seen the most impact from mining in the entire Peshastin Watershed, at least from current activity (USFS 1999f). Impacts include camps located inside riparian areas, removal of LWD and boulders for dredging access, and removal of streambank vegetation for access. However, in the riparian habitat in the lower 2 miles of Scotty Creek is still in fair condition with some mature trees and only moderate loss of connectivity (S. Tift, Longview Fibre, pers. comm., 2001).

### Channel Conditions/Dynamics

#### Streambank Condition

Peshastin Creek. From the mouth upstream to Ingalls Creek (RM 9.0), the relative mobility of channel features and the patterns of deposition and erosion indicate the stream channel is unstable and seeking equilibrium (Cappellini 1998). Particularly, stream reaches adjacent to State Hwy. 97 are not stable (B. Steele, WDFWF, pers. comm., 2001). Along Peshastin Creek, where bank stabilization efforts (i.e. riprap and berms) have halted lateral migration and protected the toe of slopes, bank erosion on these site have been controlled. However, in a reach context, stream channel stabilization work is another factor degrading the stream’s functioning condition.

Peshastin Creek. In 1986, it was determined that the channel was widening at the Ruby Creek Slide location (RM 10.5), destabilizing the toe of the State Highway 97 fill (USFS 1999f). The toe-cutting increased with the 1990 flood event and the number of large, step pool creating boulder decreased in the reach. The 1996 flood event resulted in a major movement of the slide, washing out the highway adjacent to the slide and three culverts downstream. The WDOT placed gabions and built up the highway level. This has created a channel control point on the highway side of the slide, likely causing additional erosion from the stream at the toe of the slide. This is the main chronic sediment input to Peshastin Creek in the watershed (USFS 1999f).

Peshastin Creek. With the construction of State Hwy. 97, 19,317 feet of the Peshastin Creek stream channel was reconstructed (USFS 1999f). In addition, at the Tronsen Creek confluence a bedrock outcrop was blasted through forcing the confluence of Peshastin and Tronsen creeks further upstream. Tronsen used to meander past the mouth of Magnet Creek (RM 14.8) and then enter Peshastin Creek. Tronsen Creek's original channel was filled in by highway construction which abandoned the meander at Magnet Creek (USFS 1999f).

Negro Creek. Past mining impacts have affected the morphology of the stream (USFS 1999f). Large piles of mine tailings have forced the stream energy into channel banks and established side channels (USFS 1999f). Mining activity has also resulted in a reduction in LWD inputs to the stream; floodplain disturbance from roads and mining camps which, due to the valley morphology, are generally within 40 feet of the creek; and erosion from hydraulic mining scars, some of which have never revegetated (USFS 1999f).

Tronsen Creek. Bank erosion is prevalent due to channel confinement and resultant floodplain loss from construction and placement of State Highway 97. This increases the potential for channel scour during flood events (USFS 1999f).

Shaser, N. Fk. Shaser, and Middle Fork Shaser Creeks. Dredging and rerouting stream sections associated with mining activities has reduced streambanks stability and increased sediment (USFS 1999f).

Scotty Creek. High road densities and riparian roads, timber harvest and riparian harvest, and mining have destabilized stream banks and removed structure from the channel. As a result, Scotty Creek is degrading and entrenched deeply within its floodplain from the mouth to RM 0.75 (USFS 1999f). Mining activity is extensive in the lower portion of the drainage. Currently, mining suction dredging has scoured deep holes, redirected the channel and removed vegetation (USFS 1999f).

### Floodplain Connectivity

Peshastin Creek. The location of State Hwy. 97 forced the abandonment of 34% (194 acres) of the total acres of floodplain (565 acres) along Peshastin Creek from the mouth upstream to just below the Tronsen Creek confluence (USFS 1999f). Additionally, construction of the highway included 19,317 feet of mainstem channel construction to straighten Peshastin Creek (USFS 1999f). The resultant straightening of meander bends during stream reconstruction reduced the length of the creek by 0.8 miles (USFS 1999f). These alterations, plus clearing within the floodplain, conversion of floodplain to agriculture and residential use, and water withdrawals have forced the lower reach of the creek into an unstable channel morphology. During flood events, increased discharges have degraded the channel in reaches confined by the highway, increasing stream gradient and transport capacity (USFS Peshastin Watershed Assessment 1999f). This is consistent with the principals of channel-forming processes where the natural response to

increased discharge is either an increase in channel width or an increase in channel depth (Montgomery and Buffington 1993). The photo history analysis conducted by the USFS details channel responses to the alterations on a reach basis in relation to their pre-highway geomorphological condition (USFS 1999f).

Peshastin Creek. From Camas Creek (RM 6.0) upstream to Tronsen Creek (RM 13.7) 25% (68 acres) of floodplain habitat were lost during the channelization of 10, 426 feet of stream channel during the construction of State Highway 97. The resultant straightening of meander bends during stream reconstruction reduced the length of the creek by 0.5 miles in this reach (USFS 1999f). From Hansel Creek (RM 8.4) to Negro Creek (RM 11.1) alone, the entire 3,590 foot segment was reconstructed during the highway construction. Previously, channel had meandered across the wide floodplain in this reach, providing diverse habitat. Private development at the mouth of Ingalls Creek (RM 9.0) increased between 1975 and 1986 further confining the floodplain in this reach. As a result, the channel in this location has incised. This is a symptom of channelization resulting from the stream's inability to dissipate energy through channel migration (USFS 1999f).

Peshastin Creek. The stream reach from Shaser Creek to Scotty Creek (RM 14.2 – 15.4) has been heavily impacted by mining. Suction dredging has altered the substrate and LWD component in this reach by removing wood from the channel and scouring channels down to bedrock. The channel has become entrenched in its floodplain at the upper end of this segment; some sideslopes also cut to bedrock (USFS 1999f).

Ingalls Creek. The lowest one mile of Ingalls Creek is in private ownership. It is a response reach and, as expected, shows evidence of frequent channel changes although the old channels show no evidence of having been accessed in the recent past. There are roads and homes within the channel migration zone in the lower mile also, however it is uncertain to what extent, if any, this development (roads and homes) has forced the abandonment of the old channels. Currently the main channel is confined by alluvial deposits (USFS 1999f). The remainder of the Ingalls Creek drainage is almost completely located within the Alpine Lakes Wilderness and is unaltered.

Ruby Creek. The floodplain naturally ranges from 5 to 65 feet from the mouth upstream to RM 0.5 where the channel gradient is about 8 percent. The USFS Rd. 7204 confines the floodplain somewhat at the mouth (USFS 1990b).

Negro Creek. Past mining impacts have affected the morphology of the stream (USFS 1999f). Large piles of mine tailings have forced the stream energy into channel banks and established side channels (USFS 1999f). Mining activity has also resulted in a reduction in LWD inputs to the stream; floodplain disturbance from roads and mining camps which, due to the valley morphology, are generally within 40 feet of the creek; and erosion from hydraulic mining scars, some of which have never revegetated (USFS 1999f).

Tronsen Creek. In the lower 1.5 – 2.0 miles of Tronsen Creek, the construction of State Highway 97 resulted in the loss of 65 acres (23%) of the floodplain habitat (USFS 1999f).

Tronsen Creek. In the upper reach of Tronsen Creek (approximately RMs 8.0 – 9.0), the construction of State Highway 97 resulted in approximately 1.26 miles of constructed channel changes. Prior to road construction, aerial photos show the stream reach as a complex system of meanders, side channels and beaver dams (USFS 1999f).

Shaser, N. Fk. Shaser, and M. Fk. Shaser Creeks. Roads and clearing for mining activities have greatly reduced floodplain functions (D. Driscoll, USFS, pers. comm., 2001). The USFS Rd. 7322 parallels the entire length of the North Fork and USFS Rd. 7322-210 parallels half the length of the Middle Fork.

Scotty Creek. Scotty Creek is degrading and entrenched deeply within its floodplain from the mouth to RM 0.75. This is the result of high road densities and riparian roads, timber harvest and riparian harvest, and mining activities which have destabilized stream banks and removed structure from the channel which naturally would have contributed to dissipating energy from high flows . (USFS 1999f).

#### Width/Depth Ratio

Peshastin Creek. The overall channel width of the lower 9.0 miles of Peshastin Creek is increasing and the channel is becoming less entrenched in response to increases in sediment supply, decreases in riparian vegetation structure and function, and changes in the flow regime (Cappellini 1998).

#### Entrenchment Ratio

Peshastin Creek. From Camas Creek (RM 6.0) upstream to Tronsen Creek (RM 13.7) 25% (68 acres) of floodplain habitat were lost during the channelization of 10, 426 feet of stream channel during the construction of State Highway 97. The resultant straightening of meander bends during stream reconstruction reduced the length of the creek by 0.5 miles in this reach (USFS 1999f). From Hansel Creek (RM 8.4) to Negro Creek (RM 11.1) alone, the entire 3,590 foot segment was reconstructed during the highway construction. Previously, channel had meandered across the wide floodplain in this reach, providing diverse habitat. Private development at the mouth of Ingalls Creek (RM 9.0) increased between 1975 and 1986 further confining the floodplain in this reach. As a result, the channel in the vicinity of the Ingalls Creek confluence has incised. This is a symptom of channelization resulting from the stream's inability to dissipate energy through channel migration (USFS 1999f).

Negro Creek. From RM 0.8 – 1.5 mining activity and road confinement has confined the channel and increased channel entrenchment.

Tronsen Creek. State Hwy. 97 parallels and crosses the Creek from the mouth upstream to RM 9.2 contributing to channel entrenchment (USFS 1992b).

Shaser, N. Fk. Shaser, and M. Fk. Shaser Creeks. Human-induced changes to the drainage have increased channel entrenchment. Mining activities that involved dredging down to bedrock and rerouting stream sections have reduced streambanks stability and increased sediment (USFS 1999f). Roads and clearing associated with mining activities have greatly reduced floodplain functions (D. Driscoll, USFS, pers. comm., 2001). The USFS Rd. 7322 parallels the entire length of the North Fork and USFS Rd. 7322-210 parallels half the length of the Middle Fork.

Scotty Creek. Scotty Creek is degrading and entrenched deeply within its floodplain from the mouth to RM 0.75. This is the result of high road densities and riparian roads, timber harvest and riparian harvest, and mining activities which have destabilized stream banks and removed structure from the channel which naturally would have contributed to dissipating energy from high flows . (USFS 1999f).

### Habitat Elements

#### Channel Substrate

Watershed-wide. Ocular estimates indicate that a majority of segments are visually embedded, except in Ingalls Creek where embeddedness was not a problem (USFS 1999f) and in Shaser, N. Fk. Shaser, M. Fk. Shaser, and Scotty creeks where mining by dredging has scoured the bed down to bedrock in many reaches (D. Driscoll, USFS, pers. comm., 2001).

Peshastin Creek. Between Ingalls and Tronsen creeks, where the stream is very confined by Hwy. 97, ocular estimates of embeddedness were high (USFS 1998i).

Ruby Creek. The lower 0.5 miles (8% average gradient) is dominated by sand with gravel subdominant. Spawning gravel is concentrated in small pocket pools, at pool tailouts, and behind boulders (USFS 1990b).

Negro Creek. The lower reaches of Negro Creek receives pulses of sediment, however at the time of the stream survey embeddedness was not observed to be a problem in the lower 1.5 miles of the stream (USFS 1999e).

Tronsen Creek. Sand was dominant in many reaches of Tronsen Creek which were observed to be embedded (USFS 1992b).

## Large Woody Debris

Peshastin Creek. The mainstem is the stream with the least amount of woody debris in the watershed. Low LWD counts in Peshastin Creek are mostly a result of State Highway 97 and mining activity that has been active for over 100 years (USFS 1998f). In addition, other tributary streams have been severely impacted from forest roads, mining and riparian harvest reducing LWD recruitment potential. This watershed is heavily managed in most all areas either from harvest, road building or mining. Mining has had and continues to cause removal of woody debris from the channel (USFS 1998f).

Mill Creek. Mill Creek is primarily a transport system with headwaters serving as source material for LWD transport (USFS 1999f). Timber harvest, grazing and road placement within riparian areas and the headwaters have reduced LWD recruitment; LWD is low in the surveyed lower 2.3 miles. An irrigation diversion located at approximately RM 0.8 may also negatively affect LWD transport by reducing flows and impeding passage of LWD downstream (USFS 1999f).

Hansel Creek. There is a general lack of LWD to help in creation of pools due to extensive logging which has also resulted in reduced canopy cover. Riparian habitat is mostly dominated by alder and other shrub species (USFS 1999f).

Ingalls Creek. Vegetation has been altered by past timber harvest and fire in the lower 1.3 miles and LWD levels are low as a result of decreased recruitment in the reach. The wilderness portion of the Ingalls Creek drainage has been less intensively managed in the past but stumps of large trees in the riparian zone are evidence of past impacts (USFS 1995b).

Ruby Creek. There is an extreme lack of woody debris in this drainage, the result of past timber harvest practices (USFS 1999f).

Negro Creek. Past mining impacts have affected the morphology of the stream (USFS 1999f). Large piles of mine tailings have forced the stream energy into channel banks and established side channels (USFS 1999f). Mining activity has also resulted in a reduction in LWD inputs to the stream; floodplain disturbance from roads and mining camps which, due to the valley morphology, are generally within 40 feet of the creek; and erosion from hydraulic mining scars, some of which have never revegetated (USFS 1999f).

Tronsen Creek. There is very little LWD instream due to the proximity of the road, timber harvest and loss due to campgrounds (USFS 1992b).

Shaser, N. Fk. Shaser, M. Fk. Shaser, and Scotty Creeks. Large woody debris is low due to the impacts of mining activities on riparian habitat (USFS 1992a).

## Pool Frequency

Peshastin Creek. Pool frequency is low in Peshastin Creek. Contributing factors include roads directly adjacent to the stream, lack of woody debris, mining activity over the years, and harvest of riparian vegetation. Following the 1990 flood, the number of large boulders from Ingalls Creek to Negro Creek (RM 9.0 – 11.1) decreased in number, reducing channel roughness and step pool/cascades formation. The reach is entirely bordered by State Highway 97 and has had 2,530 feet of channel straightening (48%; USFS 1999f) as a result of highway construction.

Hansel Creek. There is a general lack of LWD to help in creation of pools due to extensive logging which has also resulted in reduced canopy cover. Riparian habitat is mostly dominated by alder and other shrub species (USFS 1999f).

Ruby Creek. Pools in the lower 1.5 miles are small and average one foot in depth. The majority of pools are formed by boulders; there is very little wood instream to contribute to pool formation (USFS 1990b).

Negro Creek. Pools are small and shallow with very little woody debris to contribute to pool formation. Cover is limited for most all pools because of the lack of woody debris and depth (USFS 1998f).

Tronsen Creek. There are many pools in Tronsen Creek but they are small and shallow with very little woody debris to contribute to pool formation (USFS 1992b).

Shaser, N. Fk. Shaser, M. Fk. Shaser, and Scotty Creeks. Pool habitat is almost exclusively associated with human activity. Pools are created by rock weirs built by miners and campers trying to create instream pools. Other pools are created by miners dredging to bedrock. Pools average 1.3 feet (USFS 1992a).

## Pool Depth

Peshastin Creek. Overall pool depth is low with average depth below 1.9 feet. Cover is limited for most all pools because of the lack of woody debris and depth (USFS 1998f).

Hansel Creek. This is predominantly a transport system with gradient steadily increasing from 4 – 8 % at the mouth up to 8 – 20% and greater in the headwaters (USFS 1999f ). Increased sediment production from the drainage road system and harvest in riparian areas in this high gradient drainage impact lower gradient reaches where sediment drops out (USFS 1999f).

Ruby Creek. Pools in the lower 1.5 miles are small and average one foot in depth. The majority of pools are formed by boulders; there is very little wood instream to contribute to pool formation (USFS 1990b).

Negro Creek. Overall pool depth is low with average depth 2.5 feet. Cover is limited for most all pools because of the lack of woody debris and depth (USFS 1998f).

Tronsen Creek. There are many pools in Tronsen Creek but they are small and shallow with very little woody debris to contribute to pool formation (USFS 1992b).

Shaser, N. Fk. Shaser, M. Fk. Shaser, and Scotty Creeks. Pool habitat is almost exclusively associated with human activity. Pools are created by rock weirs built by miners and campers trying to create instream pools. Other pools are created by miners dredging to bedrock. Pools average 1.3 feet (USFS 1992a).

#### Off-Channel Habitat

Peshastin Creek. The construction of State Highway 97 in 1956 has had a very significant negative impact on Peshastin Creek, by reconstructing 19,317 feet of stream channel. The reconstruction straightened meander bends, reducing the total channel length of Peshastin Creek by 0.8 miles, from the mouth upstream to just downstream of the confluence with Tronsen Creek at RM 14.9 (USFS 1999f). The location of the highway also forced the abandonment of 34% (194 acres) of the total acres of floodplain (565 acres) along Peshastin Creek in this same reach (USFS 1999a).

Peshastin Creek. Low gradient areas between Camas (RM 6.0) and Hansel (8.4) creeks are part of the old Peshastin Creek channel and floodplain that was active before State Highway 97 construction and channel straightening. These areas, especially the area immediately across Peshastin Creek from the Hansel Creek confluence, have wetlands associated with them and could have anadromous fish use if culverts under the highway, linking them to Peshastin Creek are modified to allow passage. These areas have abundant beaver use (USFS 1999f).

Peshastin Creek. A WDOT gravel pit located between Hansel (RM 8.4) and Negro (RM 11.1) creeks was expanded in 1986. These pit sites have been placed in the old oxbows of Peshastin Creek and have reduced wetlands acreage (USFS 1999f).

Peshastin Creek. From Camas Creek (RM 6.0) upstream to Tronsen Creek (RM 13.7) 25% (68 acres) of floodplain habitat were lost during the channelization of 10, 426 feet of stream channel during the construction of State Highway 97. The resultant straightening of meander bends during stream reconstruction reduced the length of the creek by 0.5 miles in this reach (USFS 1999f). From Hansel Creek (RM 8.4) to Negro Creek (RM 11.1) alone, the entire 3,590 foot segment was reconstructed during the highway construction. Previously, channel had meandered across the wide floodplain in this

reach, providing diverse habitat. Private development at the mouth of Ingalls Creek (RM 9.0) increased between 1975 and 1986 further confining the floodplain in this reach. As a result, the channel in this location has incised. This is a symptom of channelization resulting from the stream's inability to dissipate energy through channel migration (USFS 1999f).

Peshastin Creek. At the Tronsen Creek confluence (RM 13.7) a bedrock outcrop was blasted through forcing the confluence of Peshastin and Tronsen creeks further upstream. Tronsen used to meander further downstream, past the mouth of Magnet Creek (RM 13.6) and then enter Peshastin Creek, but during State Highway 97 construction a new channel was blasted through bedrock forcing the Peshastin/Tronsen confluence upstream of Magnet Creek. Magnet Creek now enters into an old oxbow of Tronsen Creek which has culvert access to Peshastin Creek (USFS 1999f).

Ingalls Creek. The lowest one mile of Ingalls Creek is in private ownership. It is a response reach and, as expected, shows evidence of frequent channel changes although the old channels show no evidence of having been accessed in the recent past. There are roads and homes within the channel migration zone in the lower mile also, however it is uncertain to what extent, if any, this development (roads and homes) has forced the abandonment of the old channels. Currently the main channel is confined by alluvial deposits (USFS 1999f). The remainder of the Ingalls Creek drainage is almost completely located within the Alpine Lakes Wilderness and is unaltered.

Ruby Creek. The floodplain naturally ranges from 5 to 65 feet from the mouth upstream to RM 0.5 where the channel gradient is about 8 percent. The USFS Rd. 7204 confines the floodplain somewhat at the mouth (USFS 1990b).

Negro Creek. Past mining impacts have affected the morphology of the stream (USFS 1999f). Large piles of mine tailings have forced the stream energy into channel banks and established side channels (USFS 1999f). Mining activity has also resulted in a reduction in LWD inputs to the stream; floodplain disturbance from roads and mining camps which, due to the valley morphology, are generally within 40 feet of the creek; and erosion from hydraulic mining scars, some of which have never revegetated (USFS 1999f).

Tronsen Creek. In the lower 1.5 – 2.0 miles of Tronsen Creek, the construction of State Highway 97 resulted in the loss of 65 acres (23%) of the floodplain habitat and approximately 6,665 linear feet of constructed/straightened channel (USFS 1999f).

Tronsen Creek. In the upper reach of Tronsen Creek (approximately RMs 8.0 – 9.0), the construction of State Highway 97 resulted in approximately 1.26 miles of constructed channel changes. Prior to road construction, aerial photos show the stream reach as a complex system of meanders, side channels and beaver dams (USFS 1999f).

Shaser, N. Fk. Shaser, M. Fk. Shaser, and Scotty Creeks. Mining activities have greatly reduced side channel habitat by degrading riparian zones and floodplain functions (USFS 1992a).

### Water Quality

#### Temperature

Peshastin Creek. To date, the USFS has monitored instream temperature on Peshastin Creek in three areas for a number of years: below Ingalls Creek; above Ingalls Creek; and above Negro Creek; (USFS 1998f). The USFS reports that instream temperatures occasionally exceed 15.6 °C (60 °F) in late summer at RM 1.0 (USFS 1998f). The CCCD collected temperature readings at two sites on Peshastin Creek during 1992/1993 and 1999/2000: RM 1.0 on Peshastin Creek; and above the Ingalls Creek confluence at about RM 10.0 (Hindes 1994; CCCD 1999). Instream temperatures recorded in 1992/1993 and again in 1999/2000 by the CCCD (Hindes 1994; CCCD 1999) at RM 1.0 exceeded the properly functioning stream temperature conditions for salmonids of 10 –14 °C (16.8 °C on 8/16/93; 15.0 °C on 8/8/00). Peshastin Creek is also on the 303(d) (WDOE 1998) list for temperature for numerous excursions beyond the State Water quality criterion. The listing is based on data collected by EPA in 1994 at the USFS boundary (T24N R18E S21) and data collected by the Yakama Nation also in 1994, slightly upstream at T24 R18E S32 (WDOE 1998). In the lower reaches of Peshastin Creek, low flows, extremely limited vegetative cover, high levels of suspended sediment, and high air temperatures contribute to high instream temperatures during the summer months and September (Cappellini 1998).

However, the USFS does not think there is presently enough data to determine if instream temperatures are significantly different than temperatures in the historic range for Peshastin Creek upstream of RM 1.0 (D. Driscoll, USFS, pers. comm., 2001). The USFS reports that upstream of Negro Creek (RM 11.1), temperatures routinely reach the upper 60's and come close to 70°F. Between Negro Creek and Ingalls Creek (RM 9.4), the temperature decreases to the mid- to lower-60's from the influence of the cooler water from Negro Creek, but these temperatures still exceed the USFS Forest Plan and State Water quality numbers. Water temperature recordings taken immediately downstream of the Ingalls Creek confluence (RM 9.4) did not exceed the one day maximum of 61°F but did occasionally exceed the seven day maximum temperature. Water temperatures measured by the CCCD from October 1992 through September 1993 immediately above the Ingalls Creek confluence remained within the parameters for properly functioning for salmon and steelhead use (10 –14 °C; Hindes 1994). This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Mill Creek. At RM 0.8 a diversion dam which influences mid- to late-summer flows. Combined with sediment delivery from roading and harvest within riparian areas and

throughout the headwaters, temperatures may be problematic in the drainage (USFS 1999f). However, there is presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing.

Tronsen Creek. Temperatures measured by handheld thermometers on July 10, 1992 ranged from 48 – 65 °F which are above preferred levels. Measured flows were .33 cfs at the time of the temperature measurements (USFS 1992b). However, there is presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing.

Shaser and N. Fk. Shaser Creek. There is a lot of daily fluctuations in temperatures and daily peak temperatures are above preferred levels (USFS 1992a).

M. Fk. Shaser. Loss of riparian vegetation from harvest and mining impacts may have an effect on instream water temperatures (D. Driscoll, USFS, pers. comm., 2001).

#### Fine Sediment

Peshastin Creek. Information on fine sediments is limited to McNeil Core samples from two sites on Peshastin Creek: below Ingalls Creek; and Peshastin near Shaser Creek (USFS 1998f). These sites exceeded Forest Plan Standards of <20% fines <1mm, averaging 24.5%. Much of this could be due to abundant fine sediment production from year-round suction dredge mining that is prevalent throughout the watershed, highway road sanding, and high road densities (USFS 1998f). There is presently not enough data to determine the extent to which fine sediment is negatively impacting salmonid habitat and productivity in Peshastin Creek relative to historic conditions. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Peshastin Creek. The Larsen Creek drainage (RM 4.0) was a source of sediment input into Peshastin Creek during the 1996 winter flood event which followed a 1994 firestorm and subsequent salvage logging operation in the drainage (USFS 1999f). The Larsen Creek drainage is predominately a transport system except for at the mouth where it is a response reach (2-4% gradient). Sediment within the Larsen drainage will continue to be a potential problem due to landform (mini Peshastin, Washington; USFS 1999f).

Peshastin Creek. Sediment input from toe erosion at the Ruby Creek slide area (RM 10.5) is the main chronic source of sediment input into Peshastin Creek in the watershed (USFS 1999f). A major flood event in 1996 resulted in extensive erosion at this slide area (CCCD 1998). The WDOT has constructed extensive bank protection at this site to protect State Highway 97.

Peshastin Creek. The stream reach from Shaser Creek to Scotty Creek (RM 14.2 – 15.4) has been heavily impacted by mining (suction dredging has altered the substrate and LWD component in this reach), wood removal and bedrock channels entrenched in floodplain at the upper end of the segment; some sideslopes also cut to bedrock (USFS 1999f). This reach of Peshastin Creek is a response reach (USFS 1999f).

Mill Creek. Mill Creek is primarily a transport system with headwaters serving as source material for sediment transport. Increased sediment will continue to be problematic in this drainage (USFS 1999f). Of concern is the road system due to erosion potential and also harvested riparian areas. Timber harvest in riparian areas has increased the likelihood of increased sediment production and transport through stream bank erosion due to reduced channel armoring and reduced inputs of wood into the channel network to act as sediment trapping sites. The increased sediment production and rapid transport impact lower gradient reaches downstream in the channel network (USFS 1999f). An irrigation diversion located at RM 0.8 may also affect sediment transport through the reach as a result of reduced flow and impeded passage of sediment downstream (USFS 1999f).

Ruby Creek. The lower 0.5 miles (8% average gradient) is dominated by sand with gravel subdominant. Spawning gravel is concentrated in small pocket pools, at pool tailouts, and behind boulders (USFS 1990b).

Negro Creek. The lower reaches of Negro Creek receives pulses of sediment, however at the time of the stream survey embeddedness was not observed to be a problem in the lower 1.5 miles of the stream (USFS 1999e).

Tronsen Creek. Information on fine sediments is limited to McNeil Core samples from one site on Tronsen just upstream of the Peshastin Creek confluence (USFS 1998f). Fine sediment was above the Forest Plan Standards of <20% fines <1mm. Much of this could be due to abundant fine sediment production from year-round suction dredge mining that is prevalent throughout the watershed, highway road sanding, and high road densities (USFS 1998f).

Shaser Creek and N. Fk. Shaser Creek. Roading densities and placement, harvest in riparian areas, and intensive timber harvest in the uplands, have degraded the natural system resulting in increased sediment delivery to Peshastin Creek. In areas, streamside vegetation is clearcut on both banks (USFS 1999f).

Middle Fork Shaser Creek. This drainage has a naturally flashy flow regime due to a dominant parent material of Swauk sandstone which is also rich in sediment. Suction dredging and channel rerouting related to mining activities, roading densities and placement, harvest in riparian areas, and intensive timber harvest in the uplands, have degraded the natural system resulting in increased sediment delivery to Peshastin Creek (USFS 1999f).

### Water Quantity

#### Dewatering

Peshastin Creek (45.0232). At RM 2.4, the Peshastin Irrigation District operates a water diversion dam on the eastside of the creek and a screened water diversion on the west side of the creek near the confluence of Mill Creek (RM 4.8). During late summer, in years when total water diversion exceeds instream low flows, the area directly downstream of the diversion is dewatered for 100 feet (USFS 1998f). B. Steele (WDFW, pers. comm., 2001) report the channel downstream of the PID diversion will dewater all the way to the mouth in drought years. The diversion canal intercepts several tributaries to Peshastin Creek, two of which are tributaries where the flow is completely intercepted so there is no exchange with Peshastin Creek (USFS 1999f). Although Peshastin Creek is closed to diversions of water between June 15 and October 15 in addition to the current water user, no provisions have been made for minimum flow during this period.

Shaser Creek. Immediately downstream of the falls on N. Fk. Shaser Creek (RM 1.7), there was a 10' long dry section of channel between June 22 and July 2, 1992. The dewatered reach appeared to be where surface flows went subsurface (USFS 1992a).

#### Change in Flow Regime

Peshastin Creek Watershed-wide. There are 16 surface water rights permits or certificates worth a potential total diversion of 1.2 cfs. There are 36 surface water rights claims worth a potential total diversion of 84.2 cfs. There is 1 pending application for a surface water right, certificate or claim worth a potential total diversion of 0.7 cfs. There are 3 groundwater rights permits or certificates worth a potential total withdrawal of 315 gpm. There are 50 groundwater rights claims worth a potential total withdrawal of 558 gpm. There is 1 application for a groundwater rights permits or certificates pending worth a potential total of 26 gpm (Montgomery Water Group et al. 1995). Peshastin Creek is listed on the Washington State 303(d) list for instream flows (WDOE 1998). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Peshastin Creek Watershed-wide. Although there is a lack of information on flows for the Peshastin watershed, with 18% of the watershed logged, and with roads and highways paralleling the stream systems for many miles cutting off valuable water storage areas in the floodplains, it is likely that there has been a change in flow and hydrology in the watershed. Negro and Ingalls creek drainages are exceptions, due to the lack of harvest activity and water diversions in these drainages (USFS 1998f).

Peshastin Creek. The PID irrigation diversion at RM 4.8, drastically reduces instream flow downstream of the diversion during the summer and early fall. In some low water years, the water diversion dewateres a portion of the reach downstream of the diversion.

Mill Creek. Water diversion at RM 0.8 influences mid- and late-summer flows (USFS 1999f).

Tronsen Creek. The location and proximity of State Hwy. 97 have altered the natural hydrology of Tronsen Creek (M. Karrer and D. Driscoll, USFS, pers. comm., 2001).

#### *Peshastin Creek Watershed Fish Use and Distribution*

Historically, spring chinook, steelhead/rainbow, and bull trout used the Peshastin Creek watershed in greater numbers than occur there today. Steelhead were likely the more populous anadromous species spawning in this system, however coho may also have been more abundant than spring chinook (MCMCP 1998) before coho were extirpated from the region. Currently, spring chinook, steelhead, and bull trout distribution and numbers in the Peshastin Creek watershed are reduced over historic times as a result of the operation of the PID dam and diversion on Peshastin Creek, located at RMs 2.4 and 4.8, respectively (USFS 1999f). Table 5 below, describes current, known salmon, steelhead, and bull trout use in the Peshastin Creek watershed. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 5: Current, known salmon, steelhead, and bull trout use in the Peshastin Creek watershed.**

Peshastin Creek Watershed	Spring Chinook			Summer Chinook			Steelhead/Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Peshastin Creek	X	X	X				X	X	X						X
Mill Creek							X	X							
Hansel Creek		X													
Ingalls Creek		X					X	X	X				X	X	X
Ruby Creek		X					X	X	X						
Negro Creek							X	X	X						
Tronsen Creek							X	X							
Shaser Creek							X	X	X						
N. Fk. Shaser Creek							X	X							
M. Fk. Shaser Creek							X	X							
Scotty Creek							X	X							

Historically, spring chinook would have been distributed throughout the watershed where natural low flows and natural barriers did not preclude passage. Currently, in high water years, spring chinook redds have been observed in Peshastin Creek upstream of the PID water diversion, between Mill (RM 5.2 ) and Ingalls (RM 9.4 ) creeks (B. Steele, WDFW, C. Peven, Chelan PUD, and S. Hays, Chelan PUD, pers. comm., 2000), indicating the diversion is not a barrier to adult spring chinook during high flow years. Rearing spring chinook have been observed from the mouth of Peshastin Creek upstream to Magnet Creek (RM 14.8; Mullan et al. 1992; USFS 1999f; B. Steele, WDFW and S. Hays, Chelan PUD, pers. comm., 2000), and in the mouth of Ingalls Creek, Ruby and Hansel creeks. Juveniles chinook may also use other small tributaries in the watershed where habitat exists and no barriers to migration exist (i.e. low flow, high water temperatures; USFS 1999f).

Steelhead/rainbow trout use Peshastin Creek for spawning, rearing, and as a migration corridor, although thought to do so in low numbers (USFS 1998f). However, based on one year of data in a Douglas County PUD 2000 radio telemetry study, a relatively large number of steelhead appeared to be spawning in lower Peshastin Creek. Steelhead/rainbow juveniles also occur in Mill, Ingalls, Ruby, Negro, Tronsen, Shaser, Middle Shaser, North Shaser, and Scotty Creeks (TAC 2000) and in other small

tributaries in the watershed where habitat exists and no barriers to migration exist (i.e. low flow, high water temperatures; USFS 1999f). According the WDFW fish stocking records, steelhead have been planted in Peshastin Creek since 1981 and as recently as 1990; rainbow trout have been extensively stocked in the drainage also.

Historically, bull trout occurred in the watershed where habitat existed and access was not blocked by natural barriers. Peshastin Creek was once (1950's) host to a notable "run" of bull trout in the late summer (Brown 1992). This run of pre-spawning adults was targeted by knowing fishermen who accessed the habitat up into Ingalls Creek by trail into the wilderness area (Brown 1992). According to Brown (1992), the last year bull trout presence was documented in Peshastin Creek prior to the publication of his report, was 1978 (Brown 1992). In Brown's 1990 survey of Peshastin Creek, no bull trout were located, although bull trout were located in Ingalls Creek that year. In September 1995, the USFWS conducted a survey of Peshastin Creek from Ruby Creek (RM 10.5) to Scotty Creek (RM 16.6), and in Ingalls and Negro creeks. Bull trout were only located in Ingalls Creek, however the report states that because of the low sampling intensity of the survey in Peshastin Creek, there is little certainty regarding the presence of other bull trout (Ringel 1997a). In 1997, during another stream survey by the USFWS, this time of only lower Peshastin Creek (RM 0.0 to Ingalls Creek/RM 9.4), a total of 3 bull trout were identified, but only within the first 1.42 miles of Peshastin Creek (Cappellini 1998). The 1997 sightings are the last documented reports of bull trout in Peshastin Creek; no bull trout redds were observed in 2000 during the latest bull trout survey by the USFS on Ingalls Creek (C. Raekes, USFS, pers. comm., 2001). Currently, bull trout populations in the Peshastin Creek watershed are considered to be limited to a small population persisting in the Ingalls Creek drainage.

Summer chinook do not use the Peshastin Creek drainage, being mainstem Wenatchee spawners, except for possibly very limited rearing at the mouth. Brook trout have been observed in Peshastin Creek as far upstream as RM 4.84 (Cappellini 1998) and in Shaser Creek (RM 15.5 ; USFS 1998f) which flows into Peshastin Creek upstream of Ingalls Creek (RM 9.4).

#### *Peshastin Creek Watershed Summary*

The loss of channel sinuosity, floodplain function, and riparian habitat (including off channel habitat) within the channel migration zone of Peshastin Creek has had the greatest impact on salmonid production in the watershed (USFS 1998f; MCMCP 1998). The channelization of Peshastin Creek is driving habitat degradation in Peshastin Creek and has reduced spring chinook and steelhead spawning habitat. It has reduced available juvenile rearing habitat for all salmonid species, especially overwintering habitat for steelhead/rainbow trout. Restoring the channel's ability to dissipate energy and manage sediment loads, in this very productive area of the watershed is important to maintaining spring chinook, steelhead and bull trout populations in the Wenatchee subbasin

As currently operated, the PID water diversion located at RM 4.8 negatively impacts salmon, steelhead and bull trout use of the Peshastin Creek watershed (USFS 1999f). This impact is second only to the loss of channel sinuosity and the resultant decrease in the channel's ability to dissipate energy. Reduced flows and elevated instream temperatures below the point of diversion, preclude the upstream movement of migrating adult bull trout. This may contribute to the elimination of a migratory bull trout life history form from the Peshastin Creek watershed and eliminate the opportunity for individuals outside the watershed to re-supply and strengthen the Peshastin Creek watershed bull trout population. In some years, reduced flows below the diversion dam also create a passage barrier to adult spring chinook attempting to migrate up Peshastin Creek to spawn. The extent to which the diversion dam is a barrier varies with the timing, intensity and duration of the snowmelt runoff. Steelhead passage at the diversion is not affected, since adults migrate during spring runoff when high flows allow unhindered passage at the dam. Water diversion at the PID dam contribute to reduced flows below the diversion, at times dewatering the channel. This in turn reduces the total amount of available rearing habitat while contributing to elevated instream temperatures below the diversion and may lead to direct mortality of juveniles by stranding (MCMCP 1998).

Until the channel's ability to dissipate energy is restored to an appropriately functioning level and low flow conditions can be addressed, other salmonid habitat projects in the watershed will have a very limited or negligible affect on improving salmonid production. However, given these improvements, habitat impacts in upper Peshastin Creek and in tributaries to Peshastin Creek need to be addressed as well. Habitat restoration in these areas of the watershed have the greatest potential to positively affect bull trout performance. Specifically, stream reaches with elevated instream temperatures and culverts acting as fish passage barriers should be considered for restoration. Also, sources of sediment delivery to stream systems need to be evaluated to reduce overall sediment input. Additionally, degraded riparian habitat needs to be restored to improve future LWD recruitment and contribute to stream shading.

#### *Peshastin Creek Watershed Data Gaps*

- Data collection and analysis of stream flows in the Peshastin watershed (USFS 1998f).
- The cumulative effects of current gold mining activities on sediment delivery, water quality, and channel conditions (UCRTT 2001).
- The cumulative effects of past timber harvest in tributaries on sediment delivery and water quality are not fully understood, but are of concern.
- There is uncertainty as to the status of Ingalls Creek bull trout (UCRTT 2001).

### *Peshastin Creek Watershed Project Recommendations*

- Increase the Peshastin Creek's ability to dissipate energy as per the priorities discussed in the habitat restoration section of the Draft Upper Columbia Salmon Recovery Board Strategy (UCRTT 2001).
- Water removal from Peshastin Creek should leave sufficient instream flow to accommodate the needs of fish and other aquatic organisms and water quality standards (Cappellini 1998). Identify and implement water conservation measures to improve flows in lower Peshastin Creek during summer/fall low flow periods from Ingalls Creek (RM 9.4) to the mouth (UCRTT 2001).
- Develop riparian habitats in the right-of-way land along the State Highway 2 along lower Peshastin Creek (MCMCP 1998).
- Implement riparian restoration projects on Peshastin Creek and tributaries to improve fish passage, habitat function, and decrease sediment delivery.
- Minimize sediment delivery from roads, timber harvest activities, existing slides and burned areas (USFS 1999f).
- Evaluate the cumulative effects of current gold mining activities on sediment delivery, water quality, and channel conditions (UCRTT 2001).

### ICICLE CREEK WATERSHED

#### *Icicle Creek Watershed Description*

Icicle Creek originates in a high and rugged portion of the Cascade Mountains and drains an area of 214 square miles (136,960 acres; USFS 1995a) in North Central Washington. Flowing in an easterly direction, Icicle Creek runs 31.8 river miles before emptying into the Wenatchee River (RM 25.6) at the City of Leavenworth. Eighty-seven percent (119,155 acres) of the watershed is publicly owned, 74% (88,175 acres) of which is located in the Alpine Lakes Wilderness (USFS 1995a). Thirteen percent is in private ownership. There are 14 glaciers (420 acres) and 102 lakes (1,362 acres) in the watershed (Mullan et al. 1992).

The Icicle Creek watershed is the largest tributary drainage in the Wenatchee River subbasin, providing 20% of the low season flows (CCCD 1996). Precipitation ranges from 120 inches at the crest of the Cascades to 20 inches at the mouth. Extreme flows recorded in Icicle Creek vary from a minimum of 44 cfs (lowest monthly mean discharge of 66.2 cfs occurred in November 1953; Hinds 1994) to a maximum of 11,600 cfs (May 28, 1948) as measured at the USGS gauging station located above Snow Creek (RM 5.4,

upstream of all major diversions; Hinder 1994). Daily flow data are available for years 1936 to 1971 and from 1993 to the present. Natural water storage capacity exists in the high elevation cirque basins and deposits of glacial till in the valley bottoms (USFS 1995a).

The highest recreational use of any watershed in the Wenatchee WRIA occurs in the Icicle, which also has the most recreational sites of any watershed on the Leavenworth Ranger District (USFS 1995a; USFS 1998g). Water use is another high demand resource in the watershed, with the Icicle/Peshastin Irrigation District (District), the City of Leavenworth, the Leavenworth National Fish Hatchery (LNFH), the Cascade Orchard Irrigation Company (private, non-district) and multiple, small private diversions all diverting surface water from the watershed. The LNFH intake diversion dam (RM 4.5) is a fish passage barrier at low flows. The Icicle/Peshastin Irrigation District diversion dam at RM 5.7 may also hinder fish passage at low flows (M. Cappellini, USFWS, pers. comm., 2001c), limiting access to habitat in the upper Icicle Creek watershed (Mullan et al. 1992 ; USFS 1995; USFS 1998g). The fish screen at the District diversion and the fish screen at the LNFH diversion need to be updated to meet current NMFS fish screening criteria.

Timber harvest became active as a resource use in the Icicle Creek watershed beginning in the late 1960's. The USFS reports that only about 4.5% of the drainage has been harvested (USFS 1995a) while Mullan et al. (1992) reported only 1% of the watershed had been logged. Fire, both naturally and human caused, is a significant factor affecting the condition of the watershed. Residential and commercial development, including roads, occurs in the lower reach up to the USFS boundary (RM 6.0) within the floodplain and riparian areas. Although this is primarily rural/residential development, commercial development is increasing. The City of Leavenworth is located at the mouth of Icicle Creek and the Icicle Creek Road parallels the creek from the mouth up to the USFS wilderness boundary (RM 17.5).

#### *Icicle Creek Watershed Discussion of Hydrogeomorphology and Habitat Conditions*

The Icicle Creek watershed is characterized by steep valley headwalls, cirques and cirque headwalls which are typically bare rock or thinly soiled. The valley bottom through which Icicle Creek flows, is composed of a layer of thick glacial till with alluvial fans formed at the confluence of tributaries. The main channel forming processes in the Icicle Creek watershed are glaciation and seasonal runoff. The majority of stream channels (68%) are steep (>20% gradient) sediment/debris transport reaches with beds composed of cobble and boulder with bedrock stretches. In the upper reaches of some west and southwest-side drainages into Icicle Creek, collapsed glacial till deposits from steep side-slopes have dammed tributary streams creating marshy, boggy conditions and some lakes. Lower Icicle Creek below RM 3.8 (Mullan et al. 1992) is an unconfined alluvial stream, with a relatively low gradient, where large areas of floodplain deposits are located, especially at the mouth of Icicle Creek (USFS 1995a; MCMCP 1998).

In the 1920's, the Icicle/Peshastin Irrigation District gained access to water in four lakes (Square, Klonaqua, Eight Mile, and Colchuck) in the upper watershed that are now part of the Alpine Lakes Wilderness Area, to supplement irrigation district water needs when natural flows in Icicle Creek are not adequate. In 1942, the LNFH gained access to water from Upper Snow and Nada Lakes to assure a source of cold water for the hatchery in dry summers. The lakes enter Icicle Creek through Snow Creek, a tributary to Icicle Creek (RM 5.4). The LNFH and the Cascade Orchards Irrigation District Company divert water at RM 4.5; the Icicle/Peshastin Irrigation District and the City of Leavenworth divert water at RM 5.7. Water used during hatchery operations is returned to Icicle Creek at RM 2.6 after passing through the hatchery system. Additional water supply for the City of Leavenworth comes from two drilled wells along the Wenatchee River at the south end of the golf course (CCCD 1996). Other smaller, private irrigators and several additional private water diversions are located between RM 0.0 and RM 5.8. These diversions and natural low flow conditions combine for low stream flow and high water temperatures in the summer in the lowest reach of the Icicle (Mullan et al. 1992; USFS 1995a, Hindes 1994; CRITFC 1995). Without the release of water from Colchuck, Eight Mile, Klonaqua, Square, and Snow Lakes, the high level lakes which serve as the water storage reservoirs, the downstream reaches of Icicle Creek would go dry in some years (Hindes 1994). Still, during drought years, Icicle Creek is known to dewater from the LNFH intake diversion (RM 4.5) downstream to RM 2.6 where the LNFH returns flows to Icicle Creek (D. Riemen, Icicle Watershed Council, pers. comm., 2001). In 1982, minimum instream flows were established on future out-of-stream consumptive appropriations (WAC 173-545) to minimize the impact of future water use.

There have been numerous land-use/land-management related habitat impacts in the channel migration zone of Icicle Creek. Based upon analysis of aerial photographs, Chapman et al. (Chapman et al. 1994a) found that 11.2% (2,567 feet) of Icicle Creek between RM 0.2 and 2.18 had no riparian vegetation. Based on GIS mapping exercise of riprapped banks using GPS coordinates, Lorang et al. (2000) determined that 10% of the total bank length (includes both banks) from RM 0.0 – 2.8 have been riprapped (3,449 feet or 1045 meters). Impacts to the historic channel of Icicle Creek (RM 2.8 – 3.8) have been considerable and are related to the construction of dams and weirs in the channel along with the alteration of flows passing through the historic channel. The changes were part of the 1938 to 1941 construction of the LNFH. From the headgate at the top of the historic channel upstream to the USFS wilderness boundary (RM 3.8 – 17.2), impacts to the floodplain have included placement of portions of the Icicle Creek Road in the floodplain. The old-growth riparian cedar stands which originally occurred in the creek bottoms were logged off years ago adding to the loss of functions in the riparian areas. All these impairments to habitat-forming processes have contributed to habitat degradation in lower Icicle Creek.

#### *Icicle Creek Watershed Current Known Habitat Conditions*

The following list of information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field

biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but may instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### Access to Spawning and Rearing

#### Obstructions

(natural barriers are also provided here)

Icicle Creek (45.0474). The USFWS Leavenworth National Fish Hatchery (LNFH) spillway at RM 2.8 is a fish passage barrier (USFWS 2001). It is located on the canal, just upstream of the confluence of the canal and the historic (original) Icicle Creek stream channel. The canal was constructed in 1938 and used as a by-pass channel during the construction of dams and weirs in the original (historic) Icicle Creek channel (RM 2.8 – 3.8). The canal was designed to help carry high water flows around the historic stream channel once the dams and weirs were in place. The alterations to the historic channel were designed to provide a natural-type environment for spawning fish, with hatchery operations including holding and spawning, conducted principally within the historic reach. Controlling flows into this reach were therefore critical. The practice of holding and spawning adult fish in the historic channel (rather than in traditional holding ponds) was terminated in 1979. High water temperatures and large sediment deposits currently exist in the historic channel (USFWS 2001).

Icicle Creek. Hatchery operations of the dams and weirs in the historic channel of Icicle Creek, block fish passage (USFWS 2001). The downstream-most dam in the historic channel is Dam 5, located on the historic stream channel at RM 2.8, just upstream of the confluence of the canal and the historic stream channel. The upstream-most dam in the historic channel is the headgate dam (sometimes referred to as Dam 2), at RM 3.8 on the historic channel.

Icicle Creek. At RM 4.5, the water diversion dam for the LNFH and the Cascade Orchards Irrigation District Company intake, blocks fish passage at low flows (Cappellini 2001a; USFWS 2001).

Icicle Creek. During drought years, the stream is dewatered from the LNFH/ Cascade Orchards Irrigation District Company diversion dam at RM 4.5 downstream to RM 2.6, where LNFH returns flows to Icicle Creek (D. Rieman, Icicle Creek Watershed Council, pers. comm., 2001).

Icicle Creek. At RM 5.6, there is a natural boulder field. During the migration seasons in 1999 and again in 2000, a total of 75 bull trout, spring chinook, and steelhead were radio tagged, placed above the LNFH and tracked. In either year, none of these fish migrated

past the boulder field (Cappellini 2001b). The study concluded that the boulder field was a substantial velocity and gradient barrier to fish at the range of flows and water temperatures experienced between 1999 and 2000. According to the USFWS, this conclusion identifies the boulder field as the first potential natural fish passage barrier on Icicle Creek (Cappellini 2001a).

Icicle Creek. It is unknown whether the Icicle/Peshastin Irrigation District water diversion at RM 5.7 acts as a barrier to fish passage (Cappellini 2001a).

Icicle Creek. At RM 24.0 there is a natural falls that is a barrier to upstream fish passage (Mullan et al. 1992).

Eightmile Creek 45.0506. At RM 0.5 there is a natural falls fish passage barrier.

### Screens and Diversions

*NOTE:* Information on the location and condition of private water diversions other than those described below, are not available at this time. This data gap should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Watershed-wide. There are 36 surface water rights permits, certificates or claims filed with DOE in the Icicle watershed. (Montgomery Water Group et al. 1995). The status of the diversions and screens associated with the surface water rights are unknown at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Icicle Creek. The LNFH and the Cascade Orchards Irrigation District Company (privately owned, not an irrigation district) divert water at RM 4.5 (D. Rieman, Icicle Creek Watershed Council, pers. comm., 2001). The screen needs to be updated (NMFS 2000b.).

Icicle Creek. Waters of Icicle Creek are diverted by the Icicle/Peshastin Irrigation District (District) and the City of Leavenworth at RM 5.7. The District diverts water from the south side of the stream and the City diverts water from the north side of the stream (D. Rieman, Icicle Creek Watershed Council, pers. comm., 2001). The screen needs to be updated and the District is searching for funding to upgrade the facility (M. Cappellini, USFWS, Fish Biologist, pers. comm., 2001c). This diversion is the upstream-most water diversion in Icicle Creek.

## Riparian Condition

Watershed-wide. Campsites near streams are linked to increases in fines/bank erosion/ and to decreased riparian vegetation. Some campsites in the wilderness are located close to stream/lake areas and have been denuded of vegetation which has contributed to erosion into these water bodies (USFS 1995a).

Icicle Creek. The riparian vegetation in Icicle Creek from the mouth upstream to RM 2.8 is reduced in structures and function and is fragmented and poorly connected (USFWS 2001). Based upon analysis of aerial photographs, Chapman et al. (Chapman et al. 1994) found that 11.2% of the stream from the mouth upstream to RM 2.18, had riparian vegetation removed, principally from housing development. Based on GIS mapping exercise of riprapped banks using GPS coordinates, Lorang et al. (2000) determined that 10% of the total bank length (includes both banks) from RM 0.0 – 2.8 have been riprapped (3,449 feet). Homes and fields line 25% of the lower 2.8 miles where riparian vegetation has been cleared and the banks replanted with domestic grasses, trees, and shrubs. Few areas retain a narrow strip of streamside vegetation (USFWS 2001).

Icicle Creek. The riparian vegetation above the LNFH (including the historic stream reach) and below the wilderness boundary (RM 2.8 – 17.5) is dominated by small trees (9-20.9 inches diameter breast height). The quantity and quality of riparian vegetation has been reduced by campground development, road development, past timber harvests, private development, and forest fires (USFWS 2001). However, the extent of degradation to riparian habitat may be more localized in nature rather than the overall degradation of the riparian habitat for the entire reach from RM 2.8 – 17.5 (K. MacDonald, USFS, pers. comm., 2001).

Icicle Creek. In areas where the Icicle Creek road is close to the stream, riparian harvest has occurred (USFS 1995a). There are approximately 2.3 miles of road in the watershed that are encroaching upon the stream (Road Mile 4.6 - 5.1; 9.9 – 10.1; 10.7 – 10.8; 13.6 – 14.1). Outside of these areas the roads are far enough away from the stream that direct impact from the road is low (USFS 1998g).

Eightmile Creek (45.0506). Timber harvest and fire have changed the vegetation in the drainage and LWD recruitment potential is below sustainable levels. This is largely the result of roading and timber harvest (USFS 1995a).

Jack Creek (45.0543). Harvest during the 1970's reduced woody debris recruitment and canopy cover in the lowest reach of Jack Creek (USFS 1995a). The left bank is in a grass/shrub condition with scattered small trees (USFS 1994a).

## Channel Conditions/Dynamics

### Streambank Condition

Icicle Creek. Based upon analysis of aerial photographs, Chapman et al. (Chapman et al. 1994) found that 11.2% of the stream from the mouth upstream to RM 2.18, had riparian vegetation removed, principally from housing development. Based on GIS mapping exercise of riprapped banks using GPS coordinates, Lorang et al. (2000) determined that 10% of the total bank length (includes both banks) from RM 0.0 – 2.8 have been riprapped (3,449 feet). The morphology of the historic channel reach (2.8 – 3.8) has been altered considerably by the holding dams and weirs placed in the channel during construction of the LNFH. These structures coupled with changes in the historic channel's flow regime have caused the historic stream channel to evolve from riverine to wetland as sediment accumulated and vegetation encroached. Stream banks in the historic reach are stable.

Icicle Creek. Upstream of RM 3.8, specific locations where riprap has been placed include the following locations provided by road miles: 4.6 - 5.1; 9.9 – 10.1; 10.7 – 10.8; 13.6 – 14.1. The riprap placement corresponds to areas where the road is confining the stream channel. Bridge crossings also constrain the channel contributing to bank instability (USFS 1998g).

Icicle Creek. Riparian harvest and roads contribute to localized channel instability (USFS 1995a) and dispersed camp sites adjacent to the stream are linked to localized, degraded riparian habitat, linked to site specific bank erosion along the stream channel. Many areas that are adjacent to streams are being degraded by heavy use with vehicles and people. This is causing localized increased bank erosion and denuding banks (USFS 1995a).

Icicle Creek. A dike has been constructed at RM 14.7 to protect the banks at the Ida Creek Campground (RM 14.7). Banks in this reach are eroding slightly more than banks downstream and upstream. Due to the riprapped bank there is no erosion potential in the campground but the protected banks could be transferring the energy of the stream downstream and causing additional erosion (USFS 1998g).

Eightmile Creek. Timber harvest and fire have changed the vegetation and increased the exposed soils. Some drainages in Eightmile have been scoured to bedrock. (USFS 1995a).

### Floodplain Connectivity

Icicle Creek. Overall, the connectivity between Icicle Creek and its off-channel, wetland, floodplain, and riparian areas has been reduced mainly due to development, road building, water diversions, and flood damage control (USFWS 2001). In the lower 3.8

miles of Icicle Creek the channel is unstable as Icicle Creek adjusts to natural and human impacts, trying to achieve a more stable dimension, pattern, and profile that are in equilibrium with its gradient, sediment supply, and discharge. Channel confinements exacerbate this process. Reaches in upper Icicle Creek are functioning adequately except in areas where roads and bridges confine the stream channel and riprap has been placed. Five specific areas, at road mile 4.6 – 5.1, 9.9 – 10/1, 10.7 – 10.8, 13.6 – 14.1 and the Ida Campground, exist where the road system has confined the stream channel and has cut off the floodplain. There are several off-channel areas along East Leavenworth Road that are no longer connected to the stream. In several areas, riprap has been placed on stream banks and berms have been built to confine the stream and limit flood damage. Additionally, in several areas wetlands have been reduced either through draining and/or filling (Cappellini 2001a).

Icicle Creek. The historic channel (RM 2.8 – 3.8) is confined by residential development and road building. The headgate at Dam 2 and the bypass channel are currently managed for flood control, reducing overbank flows (Cappellini 2001a).

Icicle Creek. Floodplain connectivity is limited upstream of the historic channel to the wilderness boundary (RM 3.8 – 17.5) in areas where roads and bridges confine the stream channel and where riprap has been placed. Approximately 2.3 miles of portions of Icicle Road (Road Mile 4.6 - 5.1; 9.9 – 10.1; 10.7 – 10.8; 13.6 – 14.1) are positioned within the floodplain crowding the channel to one side (USFS 1995a; USFS 1998g), and a riprapped dike at the Ida Creek campground (RM 14.7) cuts off access to the floodplain (USFS 1998g). Frequently during both significant flooding events and normal run-off, portions of the roadway and prism are damaged by water and debris delivering additional sediment to the main channel (USFS 1995a).

#### Width/Depth Ratio

Icicle Creek. Channel width/depth ratios downstream of RM 2.8 are increasing (the channel is becoming wider and shallower) in response to increases in sediment supply and bank instability, decreases in riparian function and structure, and changes in flow regime (USFWS 2001).

Icicle Creek. The morphology of the historic channel (RM 2.8 – 3.8) has been altered considerably. The original design of the hatchery involved diverting the majority of Icicle Creek's flow through a canal with an energy control dam at the base and construction of holding dams and weirs in the historic creek channel. These structures coupled with changes in the historic channel's flow regime have caused the historic stream channel to evolve from riverine to wetland as sediment accumulated and vegetation encroached. Thus, there has been a reduction in channel morphology from historic dimensions (Cappellini 2001a; USFWS 2001).

Icicle Creek. Width/depth ratios for Icicle Creek upstream of the historic channel (RM 3.8) are probably similar to historic conditions based on stream measurement taken

during USFS stream surveys, with the exception of areas where roads and bridges confine the stream channel and where riprap has been placed. Five site specific areas, at road miles 4.6 - 5.1; 9.9 – 10.1; 10.7 – 10.8; 13.6 – 14.1, and the Ida Creek Campground (RM 14.7), exist where the road system has confined the stream channel and has cut off the floodplain (USFS 1998g; Cappellini 2001a; USFWS 2001).

### Entrenchment Ratio

Jack Creek (45.0543). An avulsion occurred on the lower reach of Jack Creek in the mid-70's, shortening the stream length to Icicle Creek (USFS 1995a). During the 1990 flood event, a new channel again cut through the alluvial soils, becoming the main channel. The original main channel was blocked by a large wood complex.

### Habitat Elements

#### Channel Substrate

Icicle Creek. The majority of waters flowing into Icicle Creek originate in wilderness areas and areas that have had minimal management (USFS 1998g). Even in these reaches, estimates of substrate embeddedness are high (range: 31 – 100%; USFWS 2001), the effect of naturally high sediment loads. However, for stream reaches in the lower watershed affected by land management activities, the extent of increased sediment delivery coupled with channel, flow, floodplain and riparian impacts, on substrate conditions in lower Icicle Creek, has not been fully assessed. The following limited information is available:

- Visually assessed substrate embeddedness below the LNFH (RM 0.0 – 2.8) is greater than 30% (USFWS 2001).
- The original design of the LNFH (built in 1938) involved diverting the majority of Icicle Creek's flow through a constructed canal with an energy control dam at the downstream end, and construction of a series of dams and weirs in the historic creek channel (RM 2.8 – 3.8). These structures coupled with changes in the historic channel's flow regime have caused the historic stream channel to evolve from riverine to wetland as sediment accumulated and vegetation encroached (USFWS 2001).

Eightmile Creek. Timber harvest and fire have changed the vegetation and increased the exposed soils. Some drainages in Eightmile have been scoured to bedrock. Sediment that does reach Eightmile Creek is transported to the alluvial fan at the confluence with Icicle Creek. The USFS Rd. 7601 is a major contributor of sediment to Eightmile Creek (USFS 1995a).

## Large Woody Debris

Icicle Creek. Based on a winter 1998 survey by the USFWS Mid-Columbia River Fishery Resource Office, LWD in the lower 2.8 miles is very low; only 4-10 pieces of woody debris was observed. Loss of riparian habitat function in the lower 2.8 miles through conversion to rural/residential/urban development, grazing and road placement, has reduced the opportunity for recruitment and retention of LWD in the lower 2.8 miles (USFWS 2001). Although LWD passage is restricted through the historic reach, it can pass through the canal and over the spillway at RM 2.8 into the lower reach (M. Cappellini, USFWS, pers. comm., 2001c).

Icicle Creek. No assessment of LWD in the historic stream channel has been conducted (USFWS 2001). The riparian zone mostly consists of small trees and shrubs; beavers are active in the channel facilitating the recruitment of LWD locally. However, the channel now functions as a wetland complex rather than as a riverine system as it did pre-hatchery construction (1938) and the alteration of the historic reach is no longer consistent with the recruitment of LWD from upstream of RM 3.8 nor the passage of LWD (M. Cappellini, USFWS, pers. comm., 2001c).

Icicle Creek. Stream reaches in Icicle Creek upstream RM 3.8 do not meet federal Forest Plan standards for LWD/mile (USFWS 2001). For stream reaches within the Alpine Lakes Wilderness, observed LWD levels, which are below Forest Plan standards, are the result of natural influences. For stream reaches downstream of the wilderness boundary (17.5), residential/commercial development, road construction and timber harvest, both within the channel migration zone of Icicle Creek and within drainages potentially contributing LWD to Icicle Creek, have negatively affected LWD levels. For example, downstream of the Eightmile Creek confluence (RM 9.0), there are a number of sections where the road is encroaching upon the small floodplain. Where this has happened the banks are mostly rock and any trees that might have lived there are gone, reducing the potential for LWD recruitment in these areas (USFS 1998g). Also, the construction of the riprapped dike at the Ida Creek campground (RM 14.7) reduces the potential input of LWD recruitment from this location (USFS 1998g).

Eightmile Creek. Large woody debris recruitment potential is below sustainable levels and is largely a result of roading and timber harvest (USFS 1995a).

Jack Creek (45.0543). Harvest during the 1970's reduced woody debris recruitment and canopy cover in the lower reach (USFS 1995a).

## Pool Frequency

Icicle Creek. Pool frequency in the lower 2.8 miles of Icicle Creek do not meet federal standards of 9 pools/mile for its stream width (USFWS 2001). Where pools do exist, there is typically no cover (except for depth of pool) which is usually provided by LWD

and riparian vegetation within and adjacent to stream channels (USFWS 2001). Altered flow patterns, channel confinement, loss of LWD, and increased sediment levels all contribute to decreased pool frequency.

Icicle Creek. Before construction of LNFH, the historic channel contained 4 large pools 600 to 1,000 feet long with a maximum depth of 6 – 10 feet (Brennan 1938). Currently only one large pool remains when water is backed up behind the downstream-most dam (Dam 5 at RM 3.8; USFWS 2001). The depth of this pool is dependant on how Dam 5 and the headgate are operated. Depth can range from 0 to 8 feet (M. Cappellini, USFWS, pers. comm., 2001c).

Icicle Creek. Upstream of the historic channel, pool habitat is also limited and does not meet federal Forest Plan standards (USFWS 2001). For stream reaches within the Alpine Lakes Wilderness, observed pool frequency is the result of natural influences. For stream reaches downstream of the wilderness boundary (RM 17.5), road construction and timber harvest, both within the channel migration zone of Icicle Creek and within drainages potentially contributing LWD to Icicle Creek, may be contributing to low pool frequency.

It should be noted that this area (below wilderness and above hatchery) is not dependant on LWD for pool formation; the channel type is predominantly boulder rapids with small scour pools (step pool channel morph – Rosgen B2 and B3). An analysis of stream survey data (USFS 1998m) found these reaches of Icicle Creek had similar percent riffle area as reference (wilderness) streams with similar geomorphology and precipitation gradients in the Wenatchee Highlands landtype (C. Raekes, USFS, pers. comm., 2001).

### Pool Depth

Icicle Creek. In the lower 2.8 miles, there are few pools with depth >3 feet and there is no pool cover except for depth (USFWS 2001).

Icicle Creek. In the historic stream channel there is only one pool located behind the downstream-most dam in the reach (Dam 5 at RM 3.0). The depth of this pool is dependant on how Dam 5 and the headgate are operated. Depth can range from 0 to 8 feet (M. Cappellini, USFWS, pers. comm., 2001c).

Icicle Creek. Upstream of the historic channel, pools are limited and do not meet federal Forest Plan standards (USFWS 2001). For stream reaches within the Alpine Lakes Wilderness, observed pool frequency and depth are the result of natural influences. For stream reaches downstream of the wilderness boundary, road construction, timber harvest, increased sedimentation, and decreased LWD may contribute to low pool depth.

## Off-Channel Habitat

Icicle Creek. In the lower 2.8 miles of Icicle Creek there are few backwater areas and low energy off-channel areas. Off-channel habitat is limited mainly by residential development and road building. There are several off-channel areas along the East Leavenworth Road that are no longer connected to the main channel (Cappellini 2001a).

Icicle Creek. There is some off-channel habitat, side-channels and backwater areas, in the historic channel (RM 2.8 – 3.8). However, the quantity and quality of off-channel habitat in this reach is dependent on stream flow and the management of the headgate (Dam 2 at RM 3.8). During high flows, the majority of the flow goes through the constructed bypass canal; at low flows most of the water is allowed to flow through the historic channel (USFWS 2001).

Icicle Creek. From RM 3.8 upstream, 1994 USFS stream survey data shows that 72% of upper Icicle Creek contains an adequate and diverse amount of off-channel habitat. Many side-channels, backwater areas, ponds, wetlands, and oxbows occur (Cappellini 2001a). However, there are four site specific areas where the road system has confined the stream channel (Road Mile 4.6 - 5.1; 9.9 – 10.1; 10.7 – 10.8; 13.6 – 14.1) and one area where the Ida Creek campground (RM 14.7) has cut off the floodplain (USFS 1998g).

## Water Quality

### Temperature

Icicle Creek. Icicle Creek is listed on the WDOE 303(d) list for temperature (WDOE 1998) based on 15 excursions beyond the criteria.

Icicle Creek. Downstream of the Icicle/Peshastin Irrigation District diversion dam (RM 5.7), instream temperatures during the summer can exceed 21 °C/69.8 °F (Mullan et al. 1992).

Icicle Creek. In the historic stream channel (RM 2.8– 3.8) maximum instream temperatures recorded in July and August 1999 ranged from 8.9 - 17 °C (48 - 63°F); in 2000 the range was from 13.9 – 20.5 °C (57 – 69 °F; USFWS 2001).

Icicle Creek. The USFS 1994 stream survey recorded instream temperatures as high as 64 °F (18 °C) between RM 4.8 – 17.0. This exceeds federal Forest Plan standards. The USFS Icicle Creek stream survey and stream temperatures monitoring information indicates that Icicle Creek exceeded the Wenatchee National Forest and Washington State Water Quality standards on 15 days for the maximum temperature and 37 days for the seven day average temperature (USFS 1998g). This occurred in 1997 when low flows were relatively high all year due to the extensive snow pack; water temperatures

were highest in August (USFWS 2001). However, there is presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range for these reaches of Icicle Creek (D. Driscoll, USFS, pers. comm., 2001) or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing.

### Fine Sediment

Icicle Creek. The majority of waters flow into Icicle Creek out of wilderness areas and areas that have had minimal management (USFS 1998g). Even in these reaches, high sediment loads occur naturally because the dominant land types in the watershed have high sediment delivery hazards (USFWS 2001). However, for stream reaches in the lower watershed affected by land management activities, the extent to which sediment transport and deposition has been altered by human-induced increases in sediment delivery coupled with channel changes, alteration of instream flows, fire, floodplain and riparian habitat impacts, and decreased LWD levels, is complex and has not been fully assessed. Fire and fire suppression have also played a big role in affecting sediment loading into Icicle Creek. During the period of 1908 to 1920, a 40,000 acre fire burned through the lower end of the watershed. In 1994, 12% (17,080 acres) of the Icicle Creek watershed was burned by forest fires (USFS 1995a). There is little data collected for sediment condition within the watershed, however the following information is available:

- In the lower 2.8 miles, no McNeil core sampling data has been collected. Sediment sampling is limited to: Wolman pebble counts conducted in 1998 and 1999 which records substrate <2mm in size (gravel) but does not provide data for finer particle sizes (<0.85mm; USFWS 2001); and samples from sand bars (Lorang et al. 2000). Samples taken from the sand bars were analyzed for particle sizes <2mm. Results indicated particle sizes <0.125 mm made up the greatest percent by weight of the samples (Lorang et al. 2000). Lorang observed that many of the sandy banks along the lower 2.8 miles were collapsing, with the eroded material being deposited as sand bars in this lower reach, downstream to the mouth. Additionally, a portion of the bedload delivered from the upper watershed and transported through the historic channel, was also deposited in the lower reach (Lorang et al. 2000).
- The historic channel has mostly filled in with sediment delivered from both human-induced and natural sources upstream of the hatchery. Sediment deposition and build-up in this reach is the consequence of the construction of numerous dams and weirs in-channel, and altered flows. Maximum deposition in the reach is in the order of 6 feet (Lorang et al. 2000). The reach now functions as a wetland complex where there was once a riverine system.

Icicle Creek. In June 1999, a landslide occurred naturally, on a draw that descends from Icicle Ridge. The landslide began at an elevation of 4800 feet. The failure was approximately 120 feet wide and 300 feet long to a depth of approximately 10-15feet.

This material was delivered to the depositional reaches of Icicle Creek. The main body of the failure still remains unstable (USFWS 2001).

Eightmile Creek (45.0506). Timber harvest and fire have changed the vegetation and increased the exposed soils. Sediment that reaches the mainstem is transported to the alluvial fan at the mouth and into Icicle Creek. The Eightmile Road (USFS Rd. 7601) is a major contributor of sediment (USFS 1995a).

Jack Creek (45.0543). An avulsion occurred on the lower reach of Jack Creek in the mid-70's, shortening the stream length in this reach to Icicle Creek (USFS 1995a). During the 1990 flood event, a new channel again cut through the alluvial soils, becoming the main channel. The original main channel was blocked by a large wood complex.

### Water Quantity

#### Dewatering

Icicle Creek. Without releases of water (50cfs) from Upper Snow Lake, the downstream reaches of Icicle Creek would go dry in some years (Mullan et al. 1992). Irrigation diversion removes 48%, 79% and 54% of the mean August, September and October flows, respectively (Mullan et al. 1992). Low flows in the lower reach (RM 0.0 – 5.7) are the result of natural conditions compounded by public water supply needs, irrigation diversions, and the fish hatchery diversions (Hindes 1994).

Icicle Creek. During drought years, the stream is dewatered from the LNFH diversion at RM 4.5 downstream through the canal to RM 2.6 (just downstream of the spillway) where the LNFH returns flows to Icicle Creek (D. Rieman, Icicle Creek Watershed Council, pers. comm., 2001). Dewatering can persist until the end of the summer or early fall, lasting up to about 4 months total depending on how early in the year dewatering begins. The historic channel (RM 2.8 – 3.8) does not dewater (M. Cappellini, USFWS, pers. comm., 2001a).

#### Change in Flow Regime

Icicle Creek Watershed-wide. There are 23 surface water rights permits or certificates worth a potential total diversion of 205.4 cfs. There are 13 surface water rights claims worth a potential total diversion of 9.5 cfs. There are 5 pending application for a surface water rights permits, certificates, or claims worth 8.8 cfs. There are 5 groundwater rights permits or certificates worth a potential total withdrawal of 5,178 gpm. There are 16 groundwater rights claims worth a potential total withdrawal of 369 gpm. There are 4 applications pending for groundwater rights permits, certificates or claims worth a potential total of 135 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the

Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Icicle Creek. In lower Icicle Creek there is a potential for change in peak/base flows from increased surface runoff due to residential development, roads, clearing of the riparian zone, water withdrawals, and flood protection measures (Cappellini 2001a). Icicle Creek is listed under the Washington state 303(d) Clean Water Act for not meeting in-stream flow standards (WDOE 1998).

*Icicle Creek Watershed Fish Use and Distribution*

Spring chinook, summer chinook, sockeye, steelhead/rainbow, and bull trout are known to occur in the Icicle Creek Watershed. Table 6 below, describes current, known salmon, steelhead, and bull trout use in the Icicle Creek watershed. The majority of the fish habitat in the Icicle Creek (24 river miles) and its tributaries is in a highly functional condition however, spring chinook, steelhead and fluvial bull trout are blocked from further access into the Icicle Creek watershed at RM 2.8 (LNFH spillway) on the canal, and by hatchery operations of the dams and weirs in the historic channel (RM 2.8 – 3.8; USFWS 2001). Brook trout are known to occur in the watershed both upstream and downstream of the LNFH. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 6: Current, known salmon, steelhead, and bull trout use in the Icicle Creek watershed.**

Icicle Creek Watershed	Spring Chinook			Summer Chinook			Steelhead/Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Icicle Creek	X	X			X		X	X		X	X		X	X	X
Eightmile Creek														X	
Jack Creek														X	
French Creek													X	X	X

The spring chinook spawners observed annually below the spillway (RM 2.8) in Icicle Creek are likely mostly of hatchery origin (MCMCP 1998). From 1958 to 1999, 7.69% of all redds located in the Wenatchee subbasin by the Chelan County PUD were found in the Icicle River (Appendix C – Summarized spring chinook redd counts 1958-1999). Summer chinook use in Icicle Creek is limited by the natural characteristics of the stream

which are more suitable for spring chinook, steelhead/rainbow, and bull trout rearing and spawning. Sockeye salmon do spawn in Icicle Creek downstream of RM 2.8 (1997:30 redds; 1999: 9 redds), but use is limited to strays from the Lake Wenatchee population (USFWS 2001). Rainbow trout occur upstream of the spillway (RM 2.8), in the mainstem, and in various tributaries (USFS 1998g). A few bull trout (<10 total) have also been located upstream of the spillway in Icicle Creek (RM 2.8; Free 1995) and in Jack Creek (Free 1995), Eightmile Creek (Brown 1992) and French Creek (Brown 1992). The populations are not considered strong due to the loss of connectivity to the rest of the Wenatchee River system at the LNFH dam (MacDonald et al. 2000), harvest, and past fish stocking management (K. MacDonald, USFS, pers. comm., 2001). Adult bull trout have also been observed in Icicle Creek below the LNFH spillway dam (RM 2.8; Brown 1992; WDFW 1998).

### *Icicle Creek Watershed Summary*

In the Icicle Creek watershed, natural conditions (steep gradients, water falls, flows) limit access in tributaries. However, given the total size of the watershed and the quality of the habitat, the remaining available portion of the watershed still offers a large amount of potentially productive habitat. This is dependent on fish passage through the boulder field at RM 5.6, which may vary by species and instream conditions (Cappellini 2001b). To make this habitat accessible, habitat restoration in the watershed is necessary. The Icicle Creek watershed could then potentially contribute to: 1) maintaining bull trout populations and restoring the fluvial bull trout life history form in the Icicle Creek watershed (MacDonald et al. 2000); 2) reestablishing a strong, wild steelhead run in the Icicle Creek watershed; and 3) opening additional spawning and rearing habitat to spring chinook in the Wenatchee subbasin.

While protecting functioning floodplain and riparian habitat downstream of the wilderness boundary at RM 17.5 (with emphasis placed on habitat downstream of the LNFH at RM 2.8), restoring full fish passage at human-made barriers is critical. Although there is presently disagreement as to the extent to which the boulder field at RM 5.6 is a natural barrier to fish passage, the UCSRB RTT believes restoring fish passage at human-made fish passage barriers downstream of RM 5.6 is appropriate at this time given the limited extent of information supporting lack of passage at RM 5.6. Next, low flow conditions and associated high instream temperatures in the lower reaches of Icicle Creek from RM 5.7 at the Icicle/Peshastin Creek water diversion downstream to the mouth, negatively impact salmonid fish passage and decrease habitat quantity. Opportunities to improve low flow conditions in Icicle Creek should be investigated and implemented (both well withdrawals of ground water and diversion of surface waters should be considered).

Habitat restoration projects that allow Icicle Creek to adjust to changes in flows and sediment within the channel migration zone of Icicle Creek would further improve salmonid productivity in the Icicle Creek watershed. This would include projects aimed at improving riparian habitat and floodplain functions. The lower 3.8 miles of Icicle

Creeks respond to changes in the watershed which naturally and periodically delivers large pulses of sediment, debris, and water to the channel during landslide and flood events, especially following fire events (the Eightmile Creek drainage is a major contributor of sediment to Icicle Creek). Bank stabilization, flood control, and loss of riparian habitat is limiting the stream's ability to adjust to the delivery of sediment, debris and high flows. This loss of function contributes to exacerbating bank destabilization in a naturally mobile stream section, which in turn contributes additional sediment to the stream channel. Additionally, decreased in-channel complexity and roughness from the loss of LWD further degrades channel conditions in the lower 2.8 miles. An analysis of the extent and location of the loss of channel migration, bedload and sediment transport, and existing riparian habitat and condition is needed to help direct habitat restoration projects in a coordinated, productive manner.

#### *Icicle Creek Watershed Data Gaps*

- Salmonid passage at the boulder area (RM 5.6) upstream of the LNFH (UCRTT 2001).
- The interaction of water diversions, water withdrawals, and return flows on instream flows and temperatures, including its effects of fish habitat and use.
- The extent to which Icicle Creek's ability to dissipate energy and transport bedload has been affected by human-induced changes, including the location of the impacts.

#### *Icicle Creek Watershed Project Recommendations*

- Protect functioning floodplain and riparian habitat downstream of the wilderness boundary (RM 17.5) with emphasis on protection downstream of the LNHF (RM 2.8).
- Restore human-caused fish passage.
- Investigate alternatives and feasibility of alternatives for increasing low instream flows in the Icicle.
- Analyze and assess impacts to channel function within the channel migration zone of Icicle Creek from the wilderness boundary downstream.
- Develop a coordinated plan to restoring channel function to lower Icicle Creek.
- Reduce sediment delivery from roads.

## CHIWAHA RIVER WATERSHED

### *Chiwawa River Watershed Description*

The Chiwawa River originates in five glaciers on the east side of the Cascade crest in central Washington. After flowing 37 miles, it joins with the Wenatchee River at RM 48.4 near the town of Plain (RM 46.2). The 117,000 acre watershed drains north to south with the elevation varying from 1,850 feet at the mouth to 9,082 feet at Mt. Maude. Annual precipitation varies from 30-140 inches. Eleven percent of the watershed (12,870 acres) is privately owned with most private land located below RM 4.0. Of the 89% publicly-owned lands (104,130 acres), 31% is wilderness (32,280 acres), largely in the upper watershed. Fifty-four percent (56,2302 acres) is Late-Successional Reserve (LSR)/Managed Late-Successional Areas (MLSA), and 9% is Matrix (9,372 acres). This means most of the watershed is in public ownership and protected as Wilderness Area or managed for species dependent on late-successional habitat under the Northwest Forest Plan. Habitat within these areas is highly functional and mostly unmanaged (UCRTT 2001), with the possible exception of fire suppression activities based on past fire management policy. Most of land use management in the watershed is concentrated below Chikamin Creek (13.7) where the Chiwawa River valley narrows a bit and sideslopes are less steep (USFS 1997). Maintaining the functional habitat in this reach of the Chiwawa River from Chikamin Creek to the mouth, is of primary importance. Gentle sideslopes have lent themselves well to roading and timber harvest. Recreational uses and urban development also occurs in this lower portion of the watershed where there is limited housing development in private parcels. Loss of riparian vegetation in these reaches may influence water temperature and hiding cover (UCRTT 2001).

The Chiwawa River contributes approximately 15% of the mean annual flow of the Wenatchee River at its mouth (WDOE 1982). In the mouth of the Chiwawa Watershed, glacial till impoundments have resulted in Fish Lake and other marshy bogs which serve as valuable water storage sites for the Wenatchee subbasin (USFS 1997). Peak flows recorded for the Chiwawa River include the November floods of 1990 (6,810 cfs), the spring floods of 1956 (5,080 cfs), and the spring floods of 1948 (5,880 cfs). One water diversion is located in the watershed and has the capacity to divert 30 cfs. The 6 foot wide Wenatchee-Chiwawa Irrigation Canal parallels the west edge of the river corridor for approximately 4 miles (Hindes 1994).

### *Chiwawa River Watershed Discussion of Hydrogeomorphology and Channel Processes*

Alpine glaciers moved through the resistant rock types of the Chiwawa Watershed carving out a classic U-shaped valley with wide floors and steep trough walls. The very flat, broad valley from Grouse Creek (RM 11.7) to Phelps Creek (RM 30.72) is one of the most striking feature of the watershed. As a result of glaciation, till was thickly deposited on valley floors and valley walls of the Chiwawa River, Rock, Phelps, and Buck Creeks as well as most of the minor tributaries, which were left with a mantle of glacial till (USFS 1997). Above the remnant till are steep valley troughwalls, cirques and cirque headwalls which are typically bare rock or thinly soiled. Valley trough walls in the

watershed are cut by many small, incised streams running parallel to the valley walls and emptying directly into valley streams. The till on the valley walls is very prone to debris flows, particularly in these small streams, and particularly during saturated soil conditions. Over time, the debris flows have built alluvial fans on the valley floor, delivering large quantities of mixed-size sediment and large woody debris to valley streams. Consequently the Chiwawa River tends to meander across its broad, biologically productive valley floor, affected only by the alluvial fans which constrict or re-route the main stream channel. These effects persist over the long term, continuing to shape the channel, thus regulating channel structure, and streambank delivery of LWD to the channel.

Because the glacial till through which the stream meanders provides excellent groundwater storage, wetland habitat is abundant in impoundment stretches of the floodplain, summer baseflows are high relative to other geomorphic subsections on the forest, and groundwater input helps moderate winter and summer water temperature extremes. This is important because water temperatures at the mouth of Chiwawa failed to meet Wenatchee Forest Plan and Washington state water quality standards in late summer and early fall in every year monitored (1992, 1993 and 1996-1998; USFS 1998e), raising some questions about whether elevated water temperatures may be affecting salmonid habitat use in the Chiwawa River. The Chiwawa Irrigation District (CID) water diversion (RM 3.6 on the Chiwawa River) may contribute to temperature concerns in the lower watershed. In 1999, the USFS modeled the influence of the CID's water diversion on instream temperatures during low flow year. Currently (2001) the USFS is monitoring stream temperatures at the site to field verify the modeled results. The CID has a water right for 30 cfs, although they divert about half that amount (K. MacDonald, USFS, pers. comm., 2001). Based on the initial USFS modeling, current CID operations is not expected to be of major concern to salmonid use of the Chiwawa watershed (K. MacDonald, USFS, pers. comm., 2001). Private development and past road development and timber harvests in the lower watershed may also contribute to temperature and riparian habitat concerns (USFS 1998e). Sediment, embeddedness, altered flow regime, pool habitat, LWD recruitment, channel confinement, and riparian habitat are additional concerns in the lower reach of the Chiwawa River (downstream of RM 13.8), also related to past roading and harvesting in the watershed (USFS 1998e). More data is needed to determine whether temperature concerns exist.

Big Mountain Creek which drains into the Chiwawa River at (RM 9.2), Chikamin Creek, RM 13.7, Rock Creek (RM 21.3), and Phelps Creek (RM 30.7), and are the only tributaries to the Chiwawa River which do not have a natural gradient barrier near the mouth precluding access into the drainage by anadromous fish. Of these drainages, Rock Creek is essentially undisturbed upstream of the alluvial fan where efforts to maintain USFS Road 6200 and its bridge crossing have simplified the channel in the reach. Chikamin Creek has experienced timber harvest-related impacts in the headwaters and at the mouth. The USFS Road 6200 also crosses near the mouth of Chikamin Creek, where maintenance efforts have had the same effects as on Rock Creek. Limited development in lower Chikamin Creek also may pose a threat to salmon productivity and water temperatures.

### *Chiwawa River Watershed Current Known Habitat Conditions.*

The following information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### Access to Spawning and Rearing

#### Obstructions

(natural barriers are also provided here)

Chiwawa River (45.0759). At RM 8.0 there is a fish weir run by the Chelan PUD as part of the operation of their supplementation hatchery. There is no evidence that spawning distribution has been affected by the weir and fish passage at the weir is not considered a issue (C. Peven, Chelan PUD, pers. comm., 2001). In 2001, the weir is being operated 3-4 days per week (C. Peven, Chelan PUD, pers. comm., 2001).

Chiwawa River. At RM 33.1 there is a natural falls that is a barrier to upstream fish passage.

Chikamin Creek (45.0798). Two culverts at RM 6.7 (crossing of F.S. Road 6210), located on two forks of Chikamin Creek near the headwaters, are impassable to fish (USFS 1998d) and represent the upper extent of bull trout (Brown 1992). These culverts are not listed in the USFS 2000 culvert barrier database. The 2000 survey was only the first round of what will likely be a continuing process of surveying culverts for fish passability on USFS managed lands (D. Driscoll, USFS, pers. comm., 2001).

Rock Creek (45.0842). At approximately RM 6.0 there is a log debris jam knicked into the bedrock sidewalls which has created a 15 foot high barrier. This barrier has persisted at least from 1989 to the present (C. Raekes, USFS, pers. comm., 2001).

Phelps Creek (45.0875). At approximately RM 1.0 there is a natural 8 foot falls that is a barrier to upstream fish passage.

Buck Creek (45.0882). At RM 0.4 there is a natural falls that is a barrier to upstream fish passage.

## Screens and Diversions

Chiwawa River. The Chiwawa Irrigation District (CID) water diversion is located at RM 3.6. Although the diversion is for a 33.3 cfs (USFS 1998e), the actual cfs diverted may be 12-16 cfs according to the Chiwawa watershed analysis 1996 (USFS 1998e). Mullan et al. (1992) reports that irrigation diversion has amounted to only 5%, 7%, and 7% of the mean monthly flow for August, September, and October with the minimum winter flows as low or lower than in summer with irrigation diversion. Contradicting this, the Mid-Columbia Mainstem Conservation Plan (MCMCP 1998) identified the CID water diversions as “a significant water-withdrawal impact in the upper (Wenatchee) subbasin”. The MCMCP reported that the CID diverts up to 25 cfs from the Chiwawa River claiming the diversion amounts to approximately 25% of the average September Chiwawa flow in a drought year (example: 1994) and approximately 13% of September flow in an average year. Discharge was measured at 129 cfs on Aug 10, 1992 near the mouth of the Chiwawa River, suggesting that the diversion could remove 10-25% of the flow during late summer (USFS 1997). The recent USFS recording and analysis of the CID diversion, however, has reported only about a 16 cfs diversion, not 25 cfs (K. MacDonald, USFS, pers. comm., 2001); the CID has a water right for 33.3 cfs.. In 1999, the USFS modeled the influence of the CID’s water diversion on instream temperatures during low flow year. Currently (2001) the USFS is monitoring stream temperatures at the site to field verify the modeled results. Based on the initial USFS modeling, current CID operations are not expected to be of major concern to salmonid use of the Chiwawa watershed (K. MacDonald, USFS, pers. comm., 2001). The diversion is screened and the screen was redesigned in the mid-1990’s to protect fry (USFS 1997). It is unknown whether the diversion affects upstream or downstream migration (MCMCP 1998). Water diversions in the lower Chiwawa River may affect rearing habitat in low flow years (UCRTT 2001). Presently the USFS is researching flows downstream of the CID diversion and its effects on salmonid habitat use.

Watershed-wide. There are 13 surface water rights permits, certificates, or claims located within the Chiwawa watershed filed with DOE (Montgomery Water Group et al. 1995). Except for the Chiwawa Irrigation District water diversion, the status of the diversions and screens associated with the surface water rights are unknown at this time. Uncertainties are anticipated to be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Phelps Creek. The Trinity water diversion is located in Sec.14 T30N R16E (RM 1.75), approximately 0.75 miles upstream of the 8 foot natural falls at RM 1.0 which blocks upstream fish passage. The diversion does not block upstream fish passage, and may not capture significant amounts of downstream migration because water is taken from a backwater above the falls barrier (D. Rife, USFS, pers. comm., 2000). The diversion is not thought to pose a sediment problem, but it can remove a significant proportion of flow, even 100% at times, although natural springs and seeps quickly re-water the channel downstream (D. Rife, USFS, pers. comm., 2000). However, in recent years, the water diversion was updated to increase the efficiency of operations and to reduce the

amount of water being removed from the stream (D. Driscoll, USFS, pers. comm., 2001). The diversion provides power to private development at Trinity. Bull trout are not known to occur above the falls barrier; westslope cutthroat are abundant above the falls (USFS 1998e). The Trinity diversion is currently being relicensed under FERC (USFS 1998e).

### Riparian Condition

Chiwawa River. Roads in riparian areas and riparian vegetation removal, primarily from urban development on private land, in the riparian zone along the mainstem Chiwawa River downstream of Goose Creek (RM 5.5) has locally degraded riparian habitat (USFS 1997). Timber harvest and roading has also affected the riparian condition in localized reaches of Clear (RM 1.9), Goose (RM 4.0) and Deep (RM 5.5) creeks, all of which flow into this lower reach of the Chiwawa River. The proximity of roads and harvest units in these tributary drainages have resulted in channel confinement, sediment delivery, and reduced canopy and LWD input for these streams flowing into the lower Chiwawa River (USFS 1997).

Chiwawa River. Shoreline habitat development with associated riparian habitat degradation, has occurred along the Chiwawa River from the mouth upstream to RM 5.0 and near the confluence of Chikamin Creek (RM 13.8; MCMCP 1998). However, impacts are localized and not problematic on a watershed scale, with the river functioning very closely to its naturally functioning state (K. MacDonald, USFS, pers. com., 2001).

Chiwawa River. Bank erosion and habitat alterations have occurred adjacent to several campgrounds along the Chiwawa River (USFS 1998e). The impacts, however, are minimal on a watershed scale and restoration projects have been implemented (K. MacDonald, USFS, pers. com., 2001). Campgrounds with riparian concerns included Atkinson Flat, Alpine Meadows, Meadow Creek, Phelps Creek, Rock Creek, and Schaefer Creek (USFS 1997). These concerns were addressed with flood repair monies in 1999 and 2000 (C. Raekes, USFS, pers. comm., 2001).

Chiwawa River. Grazing in Morrow and Burgess meadows appears to have altered the streambank vegetation at the site, over time (USFS 1997).

Chikamin Creek. Management has occurred in the headwaters and at the mouth where roading and timber management has resulted in fair riparian conditions (USFS 1997). The lower one mile of Chikamin Creek is presently a managed stand with shrubby vegetation (D. Driscoll, USFS, pers. comm., 2001).

## Channel Conditions/Dynamics

### Streambank Condition

Chiwawa River. Bank erosion and habitat alterations has occurred adjacent to the several campgrounds along the Chiwawa River (USFS 1998e). Campgrounds with riparian concerns included Atkinson Flat, Alpine Meadows, Meadow Creek, Phelps Creek, Rock Creek, and Schaefer Creek (USFS 1997). These concerns were addressed with flood repair monies in 1999 and 2000 (C. Raekes, USFS, pers. comm., 2001).

Rock Creek (45.0842). Human-induced impacts are limited to the alluvial fan and are related to maintenance of the USFS Rd. 6200 bridge crossing, and impacts from dispersed recreation (C. Raekes, USFS, pers. comm., 2001). Following the flood of 1947, 300 feet of Rock Creek was straightened to direct flow under the USFS Road 6200 bridge. Subsequent road repair and maintenance has included replacement of fill, construction of deflections berms, rip-rap, channel debris cleanout, and channel dredging. Recreation impacts include camping and driving on the alluvial fan. The result has been an increased width-to-depth ratio. In 1993, a habitat improvement project was implemented by the USFS to restore stream morphology and fish habitat by restoring roughness (wood, boulders) to the channel (USFS 1997).

### Floodplain Connectivity

Chikamin Creek. The channel within the alluvial fan (RM 0.0 to 1.0) has been straightened to direct flow under the 6200 Road bridge and accommodate the 6200 road location. Very close to the mouth of Chikamin Creek, the channel is still unconfined and can access its floodplain. Near the road crossing however, it has become entrenched and no longer can access the floodplain (USFS 1998d). Under natural conditions the stream channel would migrate across the fan (USFS 1997).

Rock Creek. Subsequent to the 1948 flood, 300 feet of Rock Creek was straightened to direct flow under USFS Rd. 6200 and accommodate the road location (USFS 1997).

### Width/Depth Ratio

Rock Creek. Human-induced impacts are limited to the alluvial fan and are related to maintenance of the USFS Rd. 6200 bridge crossing, and impacts from dispersed recreation (C. Raekes, USFS, pers. comm., 2001; USFS 1997). Following the flood of 1947, 300 feet of Rock Creek was straightened to direct flow under the USFS Road 6200 bridge. Subsequent road repair and maintenance has included replacement of fill, construction of deflections berms, rip-rap, channel debris cleanout, and channel dredging. Recreation impacts include camping and driving on the alluvial fan. The result has been an increased width-to-depth ratio. In 1993, a habitat improvement project was

implemented by the USFS to restore stream morphology and fish habitat by restoring roughness (wood, boulders) to the channel (USFS 1997).

### Entrenchment Ratio

Chikamin Creek. The channel within the alluvial fan (RM 0.0 to 1.0) has been straightened to direct flow under the 6200 Road bridge and accommodate the 6200 road location. Very close to the mouth of Chikamin Creek, the channel is still unconfined and can access its floodplain. Near the road crossing however, it has become entrenched and no longer can access the floodplain (USFS 1998d). Under natural conditions the stream channel would migrate across the fan (USFS 1997).

### Habitat Elements

#### Channel Substrate

Much of the upper Chiwawa watershed is presumed to approximate the natural condition because of low management intensity. Higher management intensity has occurred in the portion of the Chiwawa Creek watershed (mainstem and all tributaries) from the Chikamin Creek confluence (RM 13.7) downstream, however there is a lack of data on Channel Substrate in this portion of the watershed.

#### Large Woody Debris

Chiwawa River. Log drives occurred annually on the Chiwawa River until the late 1920's to early 30's. It is unknown when they began. Low LWD abundance downstream of the Chikamin Creek confluence (RM 13.7) may be the natural condition, or may be related to the historic log drives (USFS 1997; USFS 1998e). Riparian habitat impacts from past riparian harvest and/or roading activities in tributaries to the lower Chiwawa River downstream of RM 5.5 (Brush, Clear, Deep, Goose, Elder, Alder, and Twin Creeks) with possible impacts on potential LWD, may also contribute to reduced LWD in the lower Chiwawa River (USFS 1998e).

Rock Creek. The alluvial fan appears to have reduced LWD abundance (60 LWD/mile), likely as a result of historic channel straightening and LWD removal. Potential LWD along Rock Creek fan is good, although probably neither as abundant or large as in the pristine condition (USFS 1998e).

#### Pool Frequency

Chiwawa River. For a low gradient, large substrate, plane-bed channel type like the lower Chiwawa River downstream of the Goose Creek confluence (RM 5.5), pools frequency is 6%, below expected levels even for heavily managed streams with similar

characteristics (USFS 1998e). Historic log drives may have altered the Chiwawa River in this reach, resulting in the lack of pools today (USFS 1998e). Pool cover is also limited (USFS 1998e).

Rock Creek. Pool frequency in the alluvial fan is low (11%) which is not outside its typical range (9-30%) for a lightly managed, 2-4% gradient strams in this landtype. However, Rock Creek's channel type may have been altered when the channel was straightened. If Rock Creek on its alluvial fan was historically a gravel-dominated pool-riffle stream, it has probably lost significant pool habitat. The Chikamin Creek on its alluvial, for example, has a pool frequency of 45% (USFS 1998e).

### Pool Depth

Chiwawa River and Rock Creek. In surveyed stream reaches in the watershed, pool depth appears to be in its natural condition with no indication of pool filling with sediment. Surveyed reaches include the lower Chiwawa River and Rock Creek (USFS 1998e).

### Off-Channel Habitat

Watershed-wide. Wetland and off-channel habitat overall in the watershed is in excellent condition and functioning appropriately (USFS 1998e).

### Water Quality

#### Temperature

Chiwawa River. Water temperatures at the mouth of Chiwawa failed to meet Wenatchee Forest Plan and Washington state water quality standards from 1992 to 1998. Water temperature data collection is continuing at this site. Temperatures typically reach the low to mid-60s (°F), but even in the warmest year recorded (1994) did not exceed 69 °F (USFS 1998e). More data and analysis is needed to determine to what extent high instream temperatures are naturally occurring and to what extent, if any, water diversions at the CID diversion contribute to high instream temperatures. Recent USFS recording and analysis of the CID diversion have reported only about a 16 cfs water diversion by the CID (K. MacDonald, USFS, pers. comm., 2001); the CID has a water right for 33.3 cfs.. In 1999, the USFS modeled the influence of the CID's water diversion on instream temperatures during low flow year. Currently (2001) the USFS is monitoring stream temperatures at the site to field verify the modeled results. Based on the initial USFS modeling, current CID operations are not expected to be of major concern to salmonid use of the Chiwawa watershed (K. MacDonald, USFS, pers. comm., 2001).

Handheld thermometer readings mid-August through September 1992, indicated maximum temperatures of 68 °F in Chiwawa below Grouse Creek (RM 11.7), and

maximum temperatures of 62 °F between Chikamin (RM 13.8) and Phelps (30.2), creeks (USFS 1997). Subsequently, the 1996 USFS stream survey (mid-September to mid-October) and the USFS 1996-7 thermograph data recorded no water temperature above 55 °F, and no temperature over 61 °F was recorded at River Mile 3.0 during that year (USFS 1998e). The 1996 stream survey data and the 1996-7 thermograph data may be more representative of water temperature conditions (USFS 1998e), thermographs typically providing more accurate readings than hand-held thermometers. In summary, the data needs to be analyzed to determine if these temperatures are significantly different than temperatures in the historic range or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing (D. Driscoll, USFS, pers. comm., 2001).

### Fine Sediment

Chiwawa River. Riparian habitat impacts, primarily from urban development on private land in the riparian zone along the mainstem Chiwawa River downstream of Goose Creek (RM 5.5), and impacts from past riparian harvest and/or roading activities in tributaries to the lower Chiwawa (Brush, Clear, Deep, Goose, Elder, Alder, and Twin Creeks), may contribute to increased sediment delivery to the lower Chiwawa River (USFS 1997). Fine sediment sampling conducted in 1999 were 14.29%, 17.34% and 20.34% in three Chiwawa reaches (K. MacDonald, USFS, pers. comm., 2001). The USFS will continue to monitor sediment levels in the Chiwawa River.

Deep Creek (45.0764). Fine sediment appears to be a problem in Deep Creek (USFS 1997). Deep Creek flows into the Chiwawa River at RM 4.0. This has the potential to contribute fines to Chiwawa River.

Big Meadow Creek. Road densities exceed 3.7 mi./sq. mile (USFS 1998e). Big Meadows Creek flows into the Chiwawa River at RM 9.2. This has the potential to contribute fines to Chiwawa River.

Brush Creek. Road densities exceed 3.7 mi./sq. mile (USFS 1998e). Brush Creek flows into the Chiwawa River at RM 12.6. This has the potential to contribute fines to Chiwawa River.

### Water Quantity

#### Dewatering

Phelps Creek. The Trinity water diversion, located at Sec.14 T30N R16E, just upstream of the 8 foot natural falls at RM 0.64. The water is diverted from the main channel into a wooden flume approximately 20' in length. The diversion can remove a significant proportion of flow, even 100% at times, although natural springs and seeps quickly rewater the main channel rebuilding instream flows prior to reaching the falls (D. Rife,

USFS, pers. comm., 2001). The channel below the falls has never been observed to dewater. The Trinity diversion is currently being relicensed under FERC (USFS 1998e).

### Change in Flow Regime

Chiwawa River. The Chiwawa Irrigation District (CID) water diversion is located at RM 3.6. Although the diversion is for a 33.3 cfs (USFS 1998e), the actual cfs diverted may be 12-16 cfs according to the Chiwawa watershed analysis 1996 (USFS 1998e) Mullan et al. (1992) reports that irrigation diversion has amounted to only 5%, 7%, and 7% of the mean monthly flow for August, September, and October with the minimum winter flows as low or lower than in summer with irrigation diversion. Contradicting this, the Mid-Columbia Mainstem Conservation Plan (MCMCP 1998) identified the CID water diversions as “a significant water-withdrawal impact in the upper (Wenatchee) subbasin”. The MCMCP reported that the CID diverts up to 25 cfs from the Chiwawa River claiming the diversion amounts to approximately 25% of the average September Chiwawa flow in a drought year (example: 1994) and approximately 13% of September flow in an average year. Discharge was measured at 129 cfs on Aug 10, 1992 near the mouth of the Chiwawa River, suggesting that the diversion could remove 10-25% of the flow during late summer (USFS 1997). The recent USFS recording and analysis of the CID water diversion however, have reported only about a 16 cfs diversion, not 25 cfs (K. MacDonald, USFS, pers. comm., 2001); the CID has a water right for 33.3 cfs.. In 1999, the USFS modeled the influence of the CID’s water diversion on instream temperatures during low flow year. Currently (2001) the USFS is monitoring stream temperatures at the site to field verify the modeled results. Based on the initial USFS modeling, current CID operations are not expected to be of major concern to salmonid use of the Chiwawa watershed (K. MacDonald, USFS, pers. comm., 2001).

Chiwawa River Watershed-wide. There are 7 surface water rights permits or certificates worth a potential total diversion of 35.6 cfs. There are 6 surface water rights claims worth a potential total diversion of 32.1 cfs. There is one pending application for a surface water rights permit, certificate, or claim worth 0.7 cfs. There are 2 groundwater rights permits or certificates worth a potential total withdrawal of 78 gpm. There are 3 groundwater rights claims worth a potential total withdrawal of 27 gpm. There are 2 application for a groundwater rights permits, certificates or claims pending worth a potential total of 514 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Chiwawa River. Peak and base flows in the lower Chiwawa watershed (downstream and including Brush and Big Meadows creeks) may be altered as a result of the potential effect of high road densities (>3.7 mi./sq.mi.) on drainage patterns (USFS 1998e). Additionally, > 25% of the lower Chiwawa watershed area has been harvested, with much of the harvest and roading occurring in areas of moderate or high debris failure

hazard (USFS 1997). A USGS continuous recording gaging station located on Chiwawa River near Goose Creek (RM 5.8) has operated (with interruptions) since 1911. This location is downstream of Big Meadow (RM 9.2) and Brush (RM 12.6) creeks, but upstream of much of the other development in the watershed. No analysis of flow data has been done at this time.

Phelps Creek. The Trinity water diversion is located at Sec.14 T30N R16E, upstream of the 8 foot natural falls at RM 1.0 which blocks upstream fish passage. The diversion provides power to a private development at Trinity. The water is diverted from the main channel into a wooden flume approximately 20' in length. In the past, the diversion could remove a significant proportion of instream flow, even 100% at times, although natural springs and seeps quickly re-watered the channel downstream (D. Rife, USFS, pers. comm., 2000). The channel below the falls has never been observed to dewater. In recent years the water diversion was updated to increase the efficiency of operations and to reduce the amount of water being removed from the stream (D. Driscoll, USFS, pers. comm., 2001). The diversion provides power to private development at Trinity. Bull trout are not known to occur above the falls barrier; western cutthroat are abundant above the falls (USFS 1998e).

#### *Chiwawa River Watershed Fish Use and Distribution*

The Chiwawa watershed is characterized by a diverse and strong fish community throughout the watershed. Table 7 below, describes current, known salmon, steelhead, and bull trout use in the Chiwawa River watershed. The middle reach of the Chiwawa River between Chikamin (RM 13.7) and Phelps (RM 30.7) creeks, supports the strongest spring chinook spawning population in the Wenatchee subbasin (by redd counts). It is one of only two watersheds in the Wenatchee subbasin providing the bulk of spring chinook redds in the Wenatchee subbasin (44.16%) from 1958 to 1999 (Appendix C – Summarized spring chinook redd counts 1958-1999), the other being Nason Creek (28.23%). Rock Creek (RM 21.3), a tributary to the Chiwawa River, is the single most productive bull trout stream (by redd counts) in the mid-Columbia River basin (USFS 1997; USFS Wenatchee National Forest Bull Trout Redd Monitoring Data 2000). Along with Rock Creek, the mainstem Chiwawa River and its tributaries help to serve as an anchor for the bull trout population in the Wenatchee River watershed (MacDonald et al. 2000). Brook trout, which are known to occur in Schaefer Lake (Schaefer Creek confluence at RM 21.7), Minnow Creek (RM 14.6), Chikamin Creek (RM 13.7), and Big Meadows Creek (RM 9.2), is probably the biggest threat to the bull trout population in the Chiwawa Watershed. Summer chinook and sockeye do not occur in the Chiwawa Watershed. Steelhead/rainbow, spring chinook, and bull trout rearing occurs in the lower portions of tributaries to the Chiwawa River where gradient does not preclude access. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 7: Current, known salmon, steelhead, and bull trout use in the Chiwawa watershed.**

Chiwawa Watershed	Spring Chinook			Summer Chinook			Steelhead/Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Chiwawa River	X	X	X				X	X	X				X	X	X
Big Meadows Creek		X					X	X							
Chikamin Creek	X	X					X	X					X	X	X
Rock Creek	X	X					X	X	X				X	X	X
Phelps Creek		X					X	X					X	X	
James Creek													X	X	
Alpine Creek													X		
Buck Creek							X	X					X	X	

The lower reach of the Chiwawa River (RM 0.0 – 13.8) is critically important as a migratory corridor for steelhead, bull trout, and spring chinook moving into the Chiwawa Watershed. The lower reach of the Chiwawa River also provides rearing habitat for steelhead and spring chinook, and limited chinook spawning. In the lower reach, Big Meadow Creek (RM 9.2) is the one tributary that is lower gradient, providing about 0.5 miles of spring chinook rearing and steelhead spawning and rearing habitat.

The middle reach of the Chiwawa River (RM 13.8- 30.7) is dominated by a meandering river channel with a wide (>0.3 miles) floodplain and numerous pools, woody debris jams and wetlands associated with old oxbows and off channel areas. This area of the mainstem Chiwawa River is where the majority of spring chinook spawning occurs in the watershed. It is also very important habitat for spring chinook rearing and steelhead spawning and rearing, including some bull trout spawning and rearing (USFS 1997). Chikamin, Rock, and Phelps (RM 30.7) creeks are tributaries entering the middle reach of the Chiwawa River. Along with Rock Creek, Chikamin and Phelps creeks represent the main spawning areas for bull trout in the middle portion of the Chiwawa Watershed (USFS 1997). Chikamin Creek (RM 13.7) and Rock Creek (RM 21.3; observed in 2001; C. Raekes, USFS, pers. comm., 2001) are the only tributaries to the Chiwawa River known to support spring chinook spawning, although very limited (about 0.5 miles).

In the upper reach of the Chiwawa River, from Phelps Creek (RM 30.7) upstream to the top of the watershed, there is little to no known use by spring chinook salmon as the gradient increases and flow decreases (USFS 1997), although limited use of lower Phelps Creek for rearing has been documented. There is a natural barrier falls on the Chiwawa River at RM 33.1. Steelhead and bull trout do use the upper portion of the Chiwawa River for spawning and rearing up to the barrier (USFS 1997). In James (RM 31.2), Alpine (RM 31.7), and Buck (RM 33.0) creeks, all tributaries to the Chiwawa River, bull trout redds were identified by Brown (1992) during bull trout spawning surveys between 1980 – 1991. Phelps Creek (RM 30.7) also provides limited spawning and rearing habitat for bull trout up to the natural barrier (RM 1.0); James Creek, along with the headwaters Chiwawa River, are also likely important bull trout rearing habitat. Steelhead are known to spawn and rear in lower Phelps Creek and lower Buck Creek up to natural barriers at RM 1.0 and 0.4, respectively. Schaefer Lake in the upper watershed, was stocked with brook trout by the state over the years and is a major source of brook trout in the drainage (USFS 1997).

### *Chiwawa River Watershed Summary*

Habitat in the Chiwawa Watershed above Chikamin Creek (RM 13.7) is highly functional. This portion of the watershed provides 90% of the spring chinook spawning for this watershed, the majority of the bull trout spawning, and a substantial portion of spring chinook, steelhead, and bull trout rearing (USFS 1998e). Protecting functioning floodplain and riparian habitat is the highest priority in this watershed, especially in the vicinity of the Chikamin Creek confluence.

Maintaining fish passage through the lower reach of the Chiwawa River is critical to sustaining spring chinook, steelhead, and bull trout populations in the Wenatchee subbasin. The lower watershed is a crucial migration corridor to spawning and rearing habitat for the migratory life histories/stages of spring chinook, steelhead, and bull trout. Although impacts to the naturally functioning condition of the lower Chiwawa River have occurred, passage is not yet thought to be hindered. However, the CID water diversion may affect salmon rearing in low flow years by contributing to lower flow conditions and associated high instream temperatures. If water temperatures are or become substantially elevated in late summer in the lower Chiwawa river, the existing excellent connectivity of this watershed with important habitat throughout the Wenatchee subbasin could be weakened. Moreover, high temperatures here could inhibit rearing chinook and steelhead habitat usage, and/or outmigration of these species to Wenatchee River in the autumn. More data is needed to determine whether temperature concerns exist. The USFS is currently monitoring temperatures at this location. Analysis of the effects of the CID water diversion on elevating instream temperatures

Bull trout spawning populations in the Chiwawa Watershed are still among the highest in the mid-Columbia basin, and although bull trout migrate through the lower reach, timing of usage does not appear to correspond with seasons of high instream temperature (mid-July through August; USFS 1998e). Elevated water temperatures in the lower Chiwawa

River do have a potential to negatively impact a very small portion of the total spring chinook salmon juvenile population in the Chiwawa Watershed (approximately 10%), which may be rearing in that reach in late July and August (USFS 1998e). However, the decline in spring chinook spawning in the Chiwawa Watershed seems to be linked to a larger spatial phenomenon, mirroring patterns throughout the Wenatchee subbasin. Likewise with steelhead, elevated instream temperatures have a potential to negatively impact rearing juveniles below the CID water diversion, coupled with a reduction of available habitat resulting from reduced flows. Rearing habitat for steelhead and spring chinook may be affected in the lower watershed, but substantial and spatially dispersed rearing areas in the upper watershed mitigate these losses.

One of the greatest threats to bull trout populations in the upper watershed is from brook trout, which could damage existing healthy bull trout through inter-breeding and competition. To date no brook trout have been observed in the upper watershed, but brook trout are well established in the lower watershed (Schaefer Lake, Minnow Creek, and especially in Chikamin Creek) and no barriers hinder brook trout access to the upper watershed (USFS 1998e).

The Chikamin Creek drainage is largely healthy and its bull trout populations strong, although impacts (brook trout introduction, mining, roads, and recreation) have occurred and future impacts (mining and private land development) may occur. Still, Chikamin Creek remains stable due to its excellent riparian vegetative condition and the channel's ability to interact with the floodplain overall. Again, protecting functioning floodplain and riparian habitat in the vicinity of Chiwawa Creek confluence is the highest priority in this watershed.

#### *Chiwawa River Watershed Data Gaps*

- Impacts of surface diversions/well water withdrawals and riparian impacts related to residential development on stream temperature and habitat availability for steelhead and spring chinook juveniles.

#### *Chiwawa River Watershed Project Recommendations*

- Protect remaining floodplain and riparian habitat on the lower Chiwawa River, particularly near the Chikamin Creek confluence (RM 13.7; MCMCP 1998; UCSRB RTT 2001).
- Develop and implement a brook trout removal program for Schaefer Lake (UCRTT 2001), Minnow Creek, Chikamin Creek and Big Meadow Creek (C. Raekes, USFS, pers. comm., 2001).

- Investigate the role of surface and well water withdrawals on instream flows and habitat use in the lower Chiwawa River. Develop strategies with water users to reduce effects, if any (UCRTT 2001).
- The lower Chiwawa River requires some riparian restoration, particularly from the mouth to the Deep Creek confluence where localized riparian habitat and streambank impacts have occurred (RM 4.0; MCMCP 1998).
- Initiate public information efforts to discourage harassment of spawning spring chinook salmon and bull trout (UCRTT 2001).
- Manage recreation areas to reduce or avoid impacts to riparian habitats (UCRTT 2001).

## NASON CREEK WATERSHED

### *Nason Creek Watershed Description*

The headwaters of Nason Creek lie in the eastern slopes of the Cascade Mountains in central Washington. Nason Creek flows east out of Lake Valhalla (elevation 4,830 feet) approximately 21 miles and then turns north for another 5 miles before emptying into the Wenatchee River at RM 53.6 just below Lake Wenatchee (RM 54.2 ). Elevations in the 69,000 acre watershed vary from 8000 feet at Snowgrass Mountain to 1865 feet at the mouth of Nason Creek. Precipitation and forest vegetation vary substantially along this elevational gradient. Annual precipitation ranges from 30 to 90 inches; 84% of the watershed receives 50-80 inches annually. Vegetation ranges from subalpine to dry forest (USFS 1996).

Twenty-two percent of the watershed is in private ownership, concentrated in the lower half of the Nason Creek Watershed. This includes private timberland holdings mostly in the Kahler (RM 5.1), Roaring (RM 8.4 ), Gill (RM 9.3 ) and Coulter creek (tributary to Roaring Creek) drainages. Matrix allocations, which is where most timber harvest takes place on USFS land, and privately owned land together make up 90% of Butcher-Kahler drainage, 85% of Gill-Roaring-Coulter, and 80% of lower Nason. The floodplain of Nason Creek below RM 15.0 has largely been converted to rural residential and recreational development and a substantial portion of the watershed below RM 15.0 has experienced roading and timber harvest. The upper watershed has experienced less of these impacts. Small portions of the Alpine Lakes and Henry M. Jackson Wilderness areas lie the headwaters and 68% of the Upper Nason subwatershed is Late Successional Reserve (LSR) or administratively withdrawn, with only 24% matrix. Wilderness, LSR, and administratively withdrawn lands make up 94% of headwaters Nason and 99% of Whitepine (USFS 1996).

Nason Creek contributes approximately 18% of the low flow of the Wenatchee subbasin (CCCD 1996). Continuous stream flow data is not available for Nason Creek but from October 1992 through September 1993, twenty flow measurements were taken near the mouth of Nason Creek at RM 0.75 by the Chelan County Conservation District (CCCD 1996). It was these measurements that were used to calculate the average flow (cfs) for the Nason Creek watershed. Low instream flows are common in August and September, a natural condition related to snow accumulation and snow melt patterns (Hindes 1994).

Recreational use in the watershed is high (USFS 1996). Nason Creek watershed is a few hours drive from the Puget Sound Metropolitan area, and is dissected by a major east/west travel route (State Highway 2) traversed by approximately 1,250,000 vehicles per year (USFS 1996). Nason Creek itself is paralleled from its mouth to RM 4.0 by State Highway 207 where it is then paralleled by State Highway 2 almost to its headwaters near Stevens Pass. Most of the other development in Nason Creek, including most of the harvest, harvest-related roads, and private land development, has occurred since 1967 (USFS 1996).

#### *Nason Creek Watershed Discussion of Hydrogeomorphology and Channel Processes*

The Nason Creek drainage was formed by glacial scour, and is dominated by steep bedrock or rocky slopes with accumulations of talus on the lower margins, and a broad, U-shaped valley floor characterized by glacial till deposits. Moderate to high subsurface water storage capacity, steep terrain, and deep, non-cohesive valley soils result in a naturally high mass wasting hazard in the watershed. Fire and debris slides are among the primary naturally occurring disturbance processes (USFS 1996).

The lower 15.4 mile reach of Nason Creek (Whitepine Creek to the mouth) is mostly a boulder-dominated, meandering, high width/depth ratio stream channel with a well developed floodplain (Rosgen C2 stream type; USFS 1996). Upstream of RM 15.4 to RM 15.9 the channel is naturally confined by valley formations with an average gradient of 7.3% (Rosgen A1 stream type). For the next 5.5 miles (RM 15.9 – 21.4, from the Burlington Northern railroad tunnel west of Royal Creek to 0.5 miles above Mill Creek), the channel is confined by the State Highway 2, the railroad and some natural valley formations (Rosgen B2 stream type). Continuing upstream for 0.7 miles (RM 21.4 to RM 22.1, about 0.5 miles below Smithbrook Creek), the channel is again confined by natural valley formations with an average gradient of 7% increasing to 15% (Rosgen A1 and A2 stream type). For the next 2.8 miles, continuing upstream to Stevens Creek (RM 24.9), the channel becomes unconfined to moderately confined (Rosgen C1 stream type). The last 1.7 miles up to Lake Valhalla, are moderately confined to confined by natural valley formations with a gradient increasing to >20% (USFS 1996). Tributary channels are typically unconfined near their mouths within the Nason Creek floodplain, becoming more confined as they move upstream into higher gradient portions of the watershed (USFS 1996).

As evidenced by aerial photo records, between 1967 and 1992, many management activities took place in the watershed. The watershed went from no observable timber harvest, few roads, and little private land development to one with many clearcuts, roads, and new private development (USFS 1996). The harvest activity and road density increased mostly between 1975 and 1985. Between 1985 and 1992, as timber harvest activity increased, mass erosion become evident. There were slope failures observed within timber harvests units and adjacent to roads. Many of these failures may have occurred during the 1990 flood (USFS 1996). Approximately 400 acres of side channels and oxbows have been cut off from the main channel of Nason Creek by the location of state highways and the railroad (USFS 1996); over 5% of the lower Nason Creek channel has been altered by riprap placement (MCMCP 1998). Channelization and constriction of Nason Creek for highway and railroad placement have also lead to changes in peak flow timing and duration and down cutting of the streambed in the lower reach (USFS 1996). Additionally, elevated instream temperatures in lower Nason Creek during summer months have been recorded. Elevated instream temperatures in upper Nason Creek are also a concern given the degraded condition of riparian habitat associated with highway riprap and riparian vegetation removal.

Of the Nason Creek tributaries, those nearest the mouth of Nason Creek have experienced the greatest negative habitat impacts. Kahler Creek may be the most negatively impacted drainage. Butcher, Coulter, Gill, and Roaring Creeks are also substantially negatively impacted. The Mill Creek drainage in the upper Nason watershed also has many negative habitat impacts. While actual impacts may be less in the Mill Creek drainage than in the lower drainages of the watershed, Mill Creek is more sensitive because most of the watershed's known bull trout spawning occurs in lower Mill Creek (USFS 1998b). Negative impacts to habitat conditions in tributaries to the mainstem, contribute to the degradation of habitat functions in the receiving streams.

#### *Nason Creek Watershed Current Known Habitat Conditions.*

The following information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

#### *Access to Spawning and Rearing*

##### Obstructions

(natural barriers are also provided here)

Nason Creek (45.0888). At RM 16.8 (Gaynor Falls) on Nason Creek there is a box canyon of bedrock falls and cascades that is a passage barrier to spring chinook and sockeye (USFS 1996).

Nason Creek. At RM 20.5 on Nason Creek (at Bygone Byways, approximately 0.5 mile above Mill Creek), there is a bedrock falls and cascades that are a barrier to steelhead, bull trout and historically, coho (USFS 1996).

Roaring Creek (45.0894). Access into Roaring Creek is negatively impacted. Roaring Creek flows into what is now a disconnected oxbow of Nason Creek; the oxbow is separated from the main channel of Nason Creek by the railroad grade which runs parallel to Nason Creek and perpendicular to Roaring Creek. Placement of the railroad grade backwaters the area in the vicinity of Roaring Creek, flooding the disconnected oxbow and the confluence of Nason and Roaring creeks up against the railroad grade. There are two culverts under the railroad grade that are inundated year round. The potential rearing habitat created by the flooded area behind the railroad grade is compromised by fish access problems created by velocities at the inundated culverts, and high water temperatures in the backwatered pool. The culvert velocities and the high water temperatures also serve as a poor attractant to juvenile fish seeking rearing habitat (D. Rife and K. MacDonald, USFS, pers. comm., 2000).

Roaring Creek. At RM 1.1 there is a natural falls that is a barrier to upstream fish passage (USFS 1996).

Coulter Creek (45.0895). Access into Coulter Creek is negatively impacted. Coulter Creek flows into what is now a disconnected oxbow of Nason Creek; the oxbow is separated from the main channel of Nason Creek by the railroad grade which runs parallel to Nason Creek and perpendicular to Coulter Creek. Placement of the railroad grade backwaters the area, in the vicinity of Coulter Creek flooding the disconnected oxbow and the confluence of Nason and Coulter creeks up against the railroad grade. Culverts under the railroad grade are inundated year round. The potential rearing habitat created by the flooded area behind the railroad grade is compromised by fish access problems created by velocities at the inundated culverts, and high water temperatures in the backwatered pool. The culvert velocities and the high water temperatures also serve as a poor attractant to juvenile fish seeking rearing habitat (D. Rife and K. MacDonald, USFS, pers. comm., 2000).

Coulter Creek. At RM 0.4 there are two culverts which act as fish passage barriers.

Coulter Creek. At RM 3.0 there is a culvert on USFS Rd. 6930 that is a barrier to fish passage.

Gill Creek (45.0902). On USFS Rd. 6930, there are three fish blocking culverts at RM's 1.7, 2.5, and 2.7 (USFS Culvert Barriers Database 2000).

Whitepine Creek (45.0918). At RM 0.5 there is a 20 foot natural falls that is a barrier to upstream fish passage (USFS 1996).

Mill Creek (45.0956). Within the first half-mile upstream from the mouth, State Hwy. 2 crosses Mill Creek twice and there are culverts at both crossings. At the first crossing at RM 0.28, the culvert under westbound State Hwy. 2 shows some evidence of being a velocity barrier to some age classes of bull trout (D. Rife, USFS, pers. comm., 2000). This culvert is a very large round pipe and the water drops 12-18 inches to the pool below. It is identified as a 100% fish passage barrier by the state, however the USFS has located between 1 and 10 bull trout redds any given year between 1996 – 2000 (USFS bull trout redd counts) in the lower 0.6 miles of Mill Creek. At the second crossing, the culvert under eastbound Hwy. 2 (RM 0.33) is an open box design and is not identified as a fish passage barrier (WSDOT Barrier Culvert Inventory; WDFW SSHEAR Fish Passage Database 2001).

Mill Creek. At RM 0.6 there is a natural bedrock barrier falls that precludes bull trout and steelhead passage upstream (USFS 1996). Ringel (1997b) did not identify a barrier falls at RM 0.6, but did place an 8-foot barrier falls upstream of the State Hwy. 2 culverts about 1-1.5 miles. However, it has been substantiated that there is indeed a barrier falls at RM 0.6 (C. Raekes, USFS, pers. comm., 2001).

#### Screens and Diversions

Watershed-wide. There are 62 surface water rights permits, certificates or claims filed with DOE in the Nason watershed. (Montgomery Water Group et al. 1995). Except for the Kahler Glenn Golf Course pump diversion and the Mill Creek Nordic Center water diversion, the status of the diversions and screens associated with the surface water rights are unknown at this time. Uncertainties are anticipated to be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Nason Creek. At RM 0.75, across from the Nason Creek Campground, is the Kahler Glenn Golf Course pump diversion. The diversion screen meets federal/state standards.

Butcher Creek. There is a water diversion into an open canal at RM 0.4. When it was last observed in 1991, the diversion was not screened (M. Rickel, CCCD, pers. comm., 2001). It is not considered a fish passage barrier (USFS 1991a).

Lanham Creek (45.0956a). The diversion dam for the Mill Creek Nordic Center water diversion at RM 0.5 is a barrier to upstream fish passage (USFS 1998b). However, Lanham Creek is so small and high gradient, its value as steelhead or bull trout habitat above the 0.5 mile mark is unclear (USFS 1998b). Its effect on instream flows in Nason Creek is unknown.

### Riparian Condition

Nason Creek. From the mouth upstream to approximately 0.25 miles upstream of Whitepine Creek (RM 15.4), channelization and constriction of lower Nason Creek by state highway, powerline, and railroad development, past riparian timber harvest, stream channel riprapping, and private land conversion to rural residential uses, have impaired riparian functions in Nason Creek below Whitepine (RM 15.4; USFS 1996; USFS 1998b). Campgrounds, cabins and private residences have removed streambank cover on private lands adjacent to Nason Creek (USFS 1996).

Nason Creek. The Nason Creek Campground lies directly adjacent to Nason Creek on both banks, a few miles upstream of the mouth of Nason Creek. Much of the bank beside the campground has been riprapped. Other impacts of Nason Creek Campground are loss of riparian trees, loss of riparian understory vegetation, and increase in impervious/compacted surfaces within the riparian zone (USFS 1998b).

Nason Creek. In low gradient reaches upstream of Whitepine Creek (RM 15.4) problems with width/depth ratios, sediment, substrate embeddedness, bank erosion, instream temperatures, floodplain connectivity, reduced LWD levels and riparian habitat conditions are an indication of impaired riparian functions (USFS 1998b).

Nason Creek. The riparian habitat from Mill Creek/Bygone Byways (RM 20.5) up through the town of Yodelin (RM 24.5) is at risk from potential development impacts associated with conversion to residential use (D. Rife, USFS, pers. comm., 2000). Loss of riparian function in these upstream reaches can negatively impacts habitat conditions in fish-bearing waters below RM 20.5.

Kahler Creek (45.0890). The Round Mountain Fire burned much of this drainage in 1994 and was followed by an intensive program of salvage logging (S. Tift, Longview Fibre, pers. comm., 2001). Additionally, floodplain development, high road densities and timber harvest have negatively impacted riparian habitat and are contributing to problems with sediment, substrate embeddedness, LWD abundance, instream temperatures, pool quantity and abundance, and bank conditions (USFS 1998b).

Roaring Creek and Gill Creek (45.0902). Substantial impacts primarily related to road development and secondarily by timber harvest, have negatively impacted riparian areas, contributing to problems with sediment and substrate embeddedness. In Gill Creek, instream temperatures are also a concern. Riparian habitat has also been negatively impacted by extensive floodplain development, and powerline and road impacts (USFS 1998b).

Coulter Creek (45.0895). Substantial negative impacts primarily related to road development and secondarily by timber harvest, have negatively impacted riparian areas (USFS 1998b).

Mill Creek. The impacts to riparian areas are mostly site-specific and upstream of RM 0.6. Impacts include the State Hwy. 2 crossing near the mouth, the powerline, gravel pits, and timber harvest activities and the resultant reduced bank stability. Most of the remaining riparian areas are intact. The development of ski runs and powerline corridors on the backside of Stevens Pass (which is in the Mill Creek headwaters area) have resulted in the removal of overstory vegetation in the vicinity of the runs, both on the uplands and within the riparian reserve. Ground cover vegetation has been maintained so that surface erosion is not a concern, but shading and the ability of the stream system in these upper areas to store and transport woody debris downstream has been interrupted on these slopes (USFS 1998b).

### Channel Conditions/Dynamics

#### Streambank Condition

Nason Creek. From RM 0.0 - 15.4 (below Whitepine Creek), eroding banks (11% for the reach and 18% in the lowest 4.5 miles of stream; Dawson et al.1995) are symptomatic of a channel artificially confined within its floodplain (K. MacDonald, USFS, pers. comm., 2000). In the lower four mile reach, activities in the floodplain that have confined the floodplain have increased instream water velocities contributing to bank destabilization particularly where riparian vegetation has been degraded or removed (D. Rife, USFS, pers. comm., 2000).

Nason Creek. Over 5% of the lower channel has been altered by riprap placement (MCMCP 1998).

Nason Creek. The Nason Creek Campground lies directly adjacent to Nason Creek on both banks, a few miles above the mouth of Nason Creek. Much of the bank beside the campground has been riprapped. Other impacts of Nason Creek Campground are loss of riparian trees, loss of riparian understory vegetation, and increase in impervious/compacted surfaces within the riparian zone.

Nason Creek. In low gradient reaches upstream of Whitepine Creek (RM 15.4) problems with width/depth ratios, sediment, substrate embeddedness, bank erosion, instream temperatures, floodplain connectivity, reduced LWD levels and riparian habitat conditions are an indication of impaired riparian functions (USFS 1998b). A significant proportions of banks in low gradient reaches upstream of the Whitepine confluence (RM 14.6) have been riprapped, largely eliminating bank vegetation and natural bank processes such as channel migration (USFS 1998b).

Kahler Creek. The substantial alteration of vegetation in the riparian zone from historic condition, is contributing to bank destabilization (USFS 1998b).

Mill Creek. Powerline cross the creek in two locations in the upper reach of Mill Creek, in the vicinity of RM 4.0. Banks at the powerline crossings are eroding with some eroding sections up to 300 feet long and 80 feet high. This destabilized section represents a very small portion of the entire reach, with the rest of the banks stable with abundant vegetation (USFS 1998b).

### Floodplain Connectivity

Nason Creek. There is a loss of floodplain connectivity from Whitepine Creek (RM 15.4) downstream to the mouth as a result of channel confinement by Highway 2, the railroad and/or floodplain development (Dawson et al. 1995; USFS 1998b). Juvenile passage into oxbows, wetlands, side channels and other key habitat has been significantly reduced by isolation of these habitats from mainstem Nason (USFS 1998b). Floodplain connectivity has mainly been impacted along the Highway 2 corridor, in unconfined, low gradient reaches (USFS 1998b). Channel confinement within the floodplain from about RM 7.0 to 10.5, has lowered channel sinuosity, which has in turn altered channel gradient, width/depth, bed roughness, and sediment storage ability (Dawson et al. 1995).

Nason Creek. In low gradient reaches upstream of Whitepine Creek (RM 15.4) problems with width/depth ratios, sediment, substrate embeddedness, bank erosion, instream temperatures, floodplain connectivity, reduced LWD levels and riparian habitat conditions are an indication of impaired riparian functions (USFS 1998b).

Roaring Creek (45.0894). Access into Roaring Creek is negatively impacted. Roaring Creek flows into what is now a disconnected oxbow of Nason Creek; the oxbow is separated from the main channel of Nason Creek by the railroad grade which runs parallel to Nason Creek and perpendicular to Roaring Creek. Placement of the railroad grade backwaters the area in the vicinity of Roaring Creek, flooding the disconnected oxbow and the confluence of Nason and Roaring creeks up against the railroad grade. There are two culverts under the railroad grade that are inundated year round. The potential rearing habitat created by the flooded area behind the railroad grade is compromised by fish access problems created by velocities at the inundated culverts, and high water temperatures in the backwatered pool. The culvert velocities and the high water temperatures also serve as a poor attractant to juvenile fish seeking rearing habitat (D. Rife and K. MacDonald, USFS, pers. comm., 2000).

Coulter Creek (45.0895). Access into Coulter Creek is negatively impacted. Coulter Creek flows into what is now a disconnected oxbow of Nason Creek; the oxbow is separated from the main channel of Nason Creek by the railroad grade which runs parallel to Nason Creek and perpendicular to Coulter Creek. Placement of the railroad grade backwaters the area , in the vicinity of Coulter Creek flooding the disconnected oxbow and the confluence of Nason and Coulter creeks up against the railroad grade. Culverts under the railroad grade are inundated year round. The potential rearing habitat created by the flooded area behind the railroad grade is compromised by fish access problems created by velocities at the inundated culverts, and high water temperatures in

the backwatered pool. The culvert velocities and the high water temperatures also serve as a poor attractant to juvenile fish seeking rearing habitat (D. Rife and K. MacDonald, USFS, pers. comm., 2000).

Gill Creek. There is a large wetland area (2 acres) near the mouth of the stream. It is formed by a beaver dam and the Burlington Northern Railroad tracks which also help to back-up the flow of Gill Creek to create the wetland.

#### Width/Depth Ratio

Nason Creek. In the mainstem below Whitepine, the substrate is very mobile compared to nearby "reference" streams such as Chiwawa River (Dawson et al. 1995). Although width/depth ratios >12 would be expected from the mouth to RM 15.4, calculated width/depth ratios of 47-50 (based on hydrologic cross-sections in the reach; USFS 1998b), indicate it is outside of its historic condition. Width/depth ratios in the low 30s are typical of reference streams in the same landtype (for example Chiwawa and White Rivers; MacDonald et al. 1998). Width/depth ratios over 40 are in the range of braided systems (Rosgen 1996). Bar development, width/depth ratios, and mobile sediment indicate a channel at risk of becoming braided. Ratios of 47-50 in the lower Nason Creek reach, indicate probable severe aggradation in this reach. (Dawson et al. 1995).

Nason Creek. In low gradient reaches upstream of Whitepine Creek (RM 15.4) problems with width/depth ratios, sediment, substrate embeddedness, bank erosion, instream temperatures, floodplain connectivity, reduced LWD levels and riparian habitat conditions are an indication of impaired riparian functions (USFS 1998b).

#### Entrenchment Ratio

No identified concerns with increasing entrenchment ratios.

#### Habitat Elements

##### Channel Substrate

Nason Creek. In the mainstem below Whitepine (RM 15.4), the substrate is very mobile compared to nearby "reference" streams such as Chiwawa River. High width/depth ratios (47-50), bar development, and mobile sediment indicate probable severe aggradation in this reach. (Dawson et al. 1995; USFS 1998b).

Nason Creek. In low gradient reaches upstream of Whitepine Creek (RM 15.4) problems with width/depth ratios, sediment, substrate embeddedness, bank erosion, instream

temperatures, floodplain connectivity, reduced LWD levels and riparian habitat conditions are an indication of impaired riparian functions (USFS 1998b).

Roaring Creek (45.0894). Stream surveyors noted "excessive amounts of fine sediment" from RM 0.7 to RM 2.4 in the Roaring Creek Stream Survey (USFS 1998b).

Coulter Creek. Channel substrate is "fair" in the lower 0.4 miles of Coulter Creek (D. Rife, USFS, pers. comm., 2000).

Gill Creek. In 1992, USFS stream surveyors noted that ten out of 36 embeddedness tests were rated >35% embedded (USFS 1998b)

Mill Creek. Abundant fine sediment is visually evident below the tailings pit, one mile upstream of the only known bull trout spawning habitat in Nason watershed (D. Rife, USFS, pers. comm., 2000).

### Large Woody Debris

Nason Creek. Large woody debris levels downstream of RM 15.0 were below USFS Forest Plan and below levels in comparable Chiwawa River reference reaches in all three sampling years of 1989, 1991 and 1996 (Dawson et al. 1995). The greatest flux of LWD during the sampling years was between approximately RM 0.0 – 7.0 (Dawson et al. 1995). This may be the effect of human-induced habitat changes (railroad, powerline corridor, highway construction, and housing development) upstream in Nason Creek between RM 7.0 – 12.25 (Dawson et al. 1995). Recruitment of LWD from tributaries into Nason Creek is limited by the railroad grade and culvert crossing near tributary confluences.

Nason Creek. In Nason Creek Campground, reduction of streambank and floodplain vegetation, and removal of hazard trees (snags) reduces the potential for LWD input to the stream (USFS 1998b).

Nason Creek. In low gradient reaches upstream of Whitepine Creek (RM 15.4) problems with width/depth ratios, sediment, substrate embeddedness, bank erosion, instream temperatures, floodplain connectivity, reduced LWD levels and riparian habitat conditions are an indication of impaired riparian functions (USFS 1998b).

Kahler Creek. Although data on LWD is lacking for Kahler Creek, mature trees are sparse in much of the riparian zone and the long-term prognosis for LWD recruitment is poor. Best professional opinion of biologists who have been on the ground is that wood abundance is probably reduced from historic levels. Kahler watershed has been significantly impacted by timber harvest and roading (USFS 1998b), and the 1994 Round Mountain Fire (S. Tift, Longview Fibre, pers. comm., 2001).

Roaring Creek. Roaring Creek is overall well below USFS forest plan standards for LWD. Roaring Creek watershed has experienced substantial timber harvesting and roading, including harvest units adjacent to the stream (USFS 1998b). Recruitment of LWD into Nason Creek is blocked by the railroad grade crossing at the mouth of Roaring Creek (M. Rickel, CCCD, pers. comm., 2001).

Coulter Creek. Road development and timber harvest, have negatively impacted riparian areas resulting in a lack of large diameter trees for potential LWD recruitment (USFS 1998b). Forest fires in the early-1900s also may have negatively impacted LWD recruitment (S. Tift, Longview Fibre, pers. comm., 2001). A 1992 USFS stream survey found 153 LWD/mile on the Nason Creek floodplain where the gradient of Coulter Creek was 1% and flows are backwatered by the railroad grade crossing near the mouth. However, impacts to riparian habitat from timber harvest and road construction have decreased LWD recruitment from upstream. Recruitment of LWD into Nason Creek is blocked by the railroad grade crossing at the mouth of Coulter Creek (M. Rickel, CCCD, pers. comm., 2001).

Gill Creek. Woody material in Gill Creek is below the Forest Standards. There should be 100 pieces of Large Woody Debris (LWD) per mile. There were 74 pieces of LWD per mile counted during the survey. Several timber sales have taken place in the watershed, some of which are adjacent to the stream. In sections of timber harvest adjacent to the stream, the riparian vegetation is limited to shrubs of alder and willow. However, there is a section of stream that was harvested adjacent to that the riparian zone where some of the small trees were left. Although Gill Creek has a steep gradient (average 20%), timber harvests may contribute to the low LWD levels instream and have reduced recruitment.

Mill Creek. Mill Creek is well below USFS forest plan standards for LWD. Situated on the crest of the Cascades, Mill Creek would normally have abundant wood due to the forested environment that extends along this stream. However, this woody debris supply has been interrupted by a variety of things including the harvest of some stream side units, the use of the stream side area around the "pit" site during the building of the railroad tunnel, the Stevens Pass Ski Area, and the BPA powerline corridors (USFS 1998b). All of these uses have caused the in-stream woody debris and the potential woody debris to decrease from natural levels (USFS 1998b). Recruitment of LWD into Nason Creek is blocked by the railroad grade crossing and culverts near the mouth of Mill Creek (M. Rickel, CCCD, pers. comm., 2001).

#### Pool Frequency

Nason Creek. From the mouth upstream to Whitepine Creek (RM 14.6), pool frequency is low based on comparison with relatively undisturbed ("reference systems") of similar morphology like the Chiwawa River. Many pool-forming factors are also poor in this reach, including LWD and sinuosity (USFS 1998b).

Nason Creek. In low gradient reaches upstream of Whitepine Creek (RM 15.4) problems with width/depth ratios, sediment, substrate embeddedness, bank erosion, instream temperatures, floodplain connectivity, reduced LWD levels and riparian habitat conditions are an indication of impaired riparian functions (USFS 1998b). Impaired stream functions may contribute to low pool frequency in the low gradient reaches of Nason upstream of Whitepine Creek.

Kahler Creek. Although no pool survey data is available for Kahler Creek, given the low LWD levels and sediment concerns, Kahler Creek likely has low pool frequency (USFS 1998b).

Roaring Creek. Pool frequency is “Fair” in the lower 1.1 river miles of Roaring Creek (D. Rife, USFS, pers. comm., 2000).

Coulter Creek. Pool frequency is low in Coulter Creek as is LWD and riparian vegetation appropriate for shading and LWD recruitment (USFS 1996).

#### Pool Depth

Nason Creek. From the mouth to Whitepine Creek (RM 14.6), most of the pools are <3 feet deep (USFS 1998b).

Nason Creek. From Whitepine Creek (RM 14.6) upstream to Smithbrook (RM 22.3), pools >3 feet in depth are below expected levels (USFS 1998b).

Roaring Creek. Roaring Creek is rated “Fair” for pool depth in the lower 1.1 river miles (D. Rife, USFS, pers. comm., 2000).

Coulter Creek. Coulter Creek is rated “Fair” for pool depth in the lower 0.4 river miles (D. Rife, USFS, pers. comm., 2000).

Mill Creek. Large pools >3 feet in depth are below expected levels. Average residual pool depth is 1.8 feet and there is evidence of pool in-filling near the gravel pit that appears to be a result of management over time of the gravel pit area (USFS 1998b).

#### Off-Channel Habitat

Nason Creek. Approximately 400 acres of side channels and oxbows have been cut off from the main channel of Nason Creek by the location of state highways and the railroad (USFS 1996). Historically, RM 0.0 – 2.5 and RM 7.0 – 10.5 had abundant side channel habitat, often beaver-channel-connected oxbow wetlands (based on remnant features still visible on the landscape). Today, Nason Creek has roughly 25% as much side channel habitat as similar reference reaches in the Chiwawa River (Dawson et al. 1995). Private

land development has also contributed to the loss of off-channel habitat. Although off-channel loss has been most severe in the lowest 15 miles of Nason Creek, it has been significant in all areas of unconfined channel, including upper Nason Creek (USFS 1998b).

### Water Quality

#### Temperature

Nason Creek. Nason Creek from the mouth to Lake Valhalla (RM 26.5) is listed on the 1998 303(d) list for temperature (WDOE 1998). Instream temperatures have been monitored throughout the summer at two locations (near the mouth and at Coles Corner, RM 4.0) since 1993. Daily maximum water temperature exceeded 61 °F, (and thus failed to meet state water quality standards and USFS forest plan standards) 41 days/yr, 75 days/yr, and 52 days/yr in 1993, 1994 and 1995 respectively. State water quality standards and forest plan standards for the 7-day average maximum were violated on 69 days/yr, 100 days/yr, and 80 days/yr, respectively. The maximum water temperature recorded in 1995 in Nason Creek was 70.7 °F (USFS 1998b).

Nason Creek. The loss of riparian habitat associated with highway riprap may contribute to increased instream temperatures in Nason Creek between Whitepine Creek (RM 14.6) and Stevens Creek (RM 23.7; USFS 1998b).

Coulter and Roaring Creeks. Harvest in the upper drainage may have a negative effect on instream temperatures (D. Rife, USFS, pers. comm., 2000).

#### Fine Sediment

Nason Creek. McNeil core sediment samples taken from three riffles in 1993 in the lower 5 miles of Nason Creek averaged 22.7% fines. This exceeds USFS forest plan standards (USFS 1998b).

Nason Creek. In the mainstem below Whitepine (RM 15.4), the substrate is very mobile compared to nearby "reference" streams such as Chiwawa River. High width/depth ratios (47-50), bar development, and mobile sediment indicate probable severe aggradation in this reach. Harvest-related landslides (i.e. the large 1990 slide across from Mill Creek) and other human-related sediment sources like the state highway, contribute sediment from the mouth of Nason Creek upstream to Stevens Creek (RM 23.7; Dawson et al. 1995; USFS 1998b).

Kahler Creek. The only Nason Creek tributary for which McNeil core information is available is Kahler Creek. In 1995, four samples were taken from each of two riffles in Kahler Creek near river mile 3.5 showed an average percent fines of the two sites was 29.8% fines < .85 mm (USFS 1998b).

Roaring Creek (45.0894). Stream surveyors noted "excessive amounts of fine sediment" from RM 0.7 to RM 2.4 in the Roaring Creek Stream Survey (USFS 1998b).

Gill Creek. Fine sediment conditions are "Fair" in the lower 0.22 miles of Gill Creek (D. Rife, USFS, pers. comm., 2000).

Mill Creek. Abundant fine sediment is visually evident below the tailings pit, one mile upstream of the only known bull trout spawning habitat in Nason watershed (D. Rife, USFS, pers. comm., 2000).

### Water Quantity

#### Dewatering

Lanham Creek (45.0956a). Mill Creek Nordic Center has a small water diversion from Lanham Creek, tributary to Mill Creek, for water use during their winter operations. They are allowed 0.05 cfs between November 15th and April 15th, and 0.11 cfs from May 1 to September 1. It is unknown to what extent, if any, the diversion has on flows in Mill Creek. The dam for this water withdrawal precludes fish passage above RM 0.5 (USFS 1998b). Lanham Creek is so small and high gradient, its value as steelhead or bull trout habitat above the 0.5 mile mark is unclear (USFS 1998b).

#### Change in Flow Regime

Nason Creek Watershed-wide. There are 27 surface water rights permits or certificates worth a potential total diversion of 3.5 cfs. There are 35 surface water rights claims worth a potential total diversion of 6.8 cfs. There are 3 pending application for a surface water rights permits, certificates, or claims worth 0.9 cfs. There are 11 groundwater rights permits or certificates worth a potential total withdrawal of 770 gpm. There are 22 groundwater rights claims worth a potential total withdrawal of 270 gpm. There are 6 application for a groundwater rights permits, certificates or claims pending worth a potential total of 2,555 gpm (Montgomery Water Group et al. 1995). The effects of the diversions and withdrawals, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

Nason Creek. Road densities in all areas of the watershed except Whitepine Creek and Smith Brook exceed 2.4 mi./sq. mi., including the lower reach of Nason Creek if non-forest roads are included (USFS 1998b). Then extent to which this may alter flow regimes, if at all, is unknown.

*Nason Watershed Fish Use and Distribution*

Table 8 below, describes current, known salmon, steelhead, and bull trout use in the Nason Creek watershed. Coho historically occurred in Nason Creek and its tributaries, but have been extirpated. Summer chinook do not occur in the watershed. Spring chinook, steelhead, sockeye and bull trout spawn and rear in the Nason Creek watershed. Brook trout were planted in some of the lakes in the watershed (USFS 1996) but there is no record of this specie’s current distribution, nor an assessment of its affect on the bull trout population in the Nason Creek Watershed. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 8: Current, known salmon, steelhead, and bull trout use in the Nason Creek watershed.**

Nason Creek Watershed	Spring Chinook			Summer Chinook			Steelhead/Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Nason Creek	X	X	X				X	X	X	X	X	X	X	X	X
Kahler Creek							X	X	X						
Roaring Creek							X	X	X						
Coulter Creek							X	X							
Gill Creek							X	X							
Whitepine Creek							X	X	X						
Mill Creek													X	X	

All spring chinook and sockeye spawning and rearing habitat in the watershed is in Nason Creek below RM 16.8 where Gaynor Falls creates a natural barrier to upstream passage for chinook and sockeye. The Nason Creek watershed is one of only two watersheds in the Wenatchee subbasin supporting the bulk of spring chinook spawning in the Wenatchee subbasin (by redd count). With 28.23% of total redds counted from 1958 to 1999, it is second only to the Chiwawa River watershed (44.16%) in percent of total redds counted in the Wenatchee subbasin from 1958 to 1999 (Appendix C – Summarized spring chinook redd counts 1958-1999).

Steelhead and migratory bull trout can pass Gaynor Falls, but cannot pass a series of natural bedrock falls further upstream at the Bygone Byways trailhead (RM 20.5) about

0.5 miles below Smithbrook Creek, making this the upper-most extent of steelhead and migratory bull trout distribution in the watershed (USFS 1998b). Steelhead are known to rear in the mainstem Nason Creek up to Gaynor Falls, in the lower 1.1 miles of Roaring Creek up to a natural barrier falls, in the lower 0.4 miles of Coulter Creek, in the lower 0.5 miles of Whitepine Creek up to a natural barrier falls, and presumably in other tributaries to Nason Creek downstream of RM 16.8 where access is not precluded by natural or human-made barriers. There is substantial steelhead habitat in the watershed, but steelhead population size in the Nason Creek watershed is unknown (USFS 1998b).

The only known bull trout spawning in the Nason Creek Watershed occurs in Nason Creek below Bygone Byways (RM 20.5) and in the lower 0.6 miles of Mill Creek. Redd counts have been very low in these areas (Nason Creek/1997-2000: 5-106 redds; Mill Creek/1996-2000: 1-10 redds; USFS 1998b) with no concentrations of spawning or rearing observed. The Nason Creek population is likely a subpopulation of a larger Upper Wenatchee River/Lake Wenatchee population (MacDonald et al. 2000).

#### *Nason Creek Watershed Summary*

The significance of the Nason Creek watershed lies in its potential contribution to spring chinook production in the Wenatchee subbasin and its connectivity to the upper Wenatchee subbasin salmonid populations, especially the bull trout subpopulation. The available quantity of steelhead habitat indicates the watershed's high potential to contribute to steelhead production. Although no concentrated spawning or rearing bull trout have been observed in the watershed, the Nason Creek watershed may be important for restoration in order to strengthen the upper Wenatchee bull trout metapopulation (MacDonald et al. 2000).

Protecting the remaining functioning floodplain and riparian habitat is the first priority in the Nason Creek watershed. Road development, conversion of the floodplain to residential uses, and timber harvest in Nason Creek and its tributaries from Whitepine Creek (RM 15.4) downstream, have degraded and reduced spawning and rearing habitat. This includes the portion of the watershed that supports the second largest spring chinook salmon spawning population (by redd count) in the Wenatchee subbasin. It also includes Mill Creek, which may be the last important spawning habitat in the watershed available to the current population of bull trout (USFS 1996). The location of highways, the railroad and powerline corridors adjacent to Nason Creek have resulted in confinement and straightening of the channel in places. Habitat restoration projects that allow Nason Creek to adjust to changes in flows and sediment within the channel migration zone is second in priority. This would include projects aimed at improving riparian habitat functions and floodplain functions, especially reconnecting off-channel habitat to the extent it is determined to cumulatively show an appreciable improvement in channel function. Habitat restoration projects aimed at reducing sediment delivery to stream channels from human-induced causes should be the third in priority. Primarily roads and secondarily timber harvest, are believed to be the dominant human-related sources of sediment and mechanism of delivery of sediment to stream channels in the Nason Creek

watershed (Nason Creek 1996). Timber harvest activities, concentrated in Coulter, Kahler, Roaring and Mill Creek drainages, have increased surface erosion, mass failures and surface runoff. The human-induced alterations to the watershed have also accelerated bank erosion in vulnerable reaches, and after the floods of 1990 and 1995, resulted in braided channel conditions in some reaches of Nason Creek below RM 15.4 (USFS 1996).

#### *Nason Creek Watershed Data Gaps*

- The cumulative effects of timber harvest, development, and road densities on sediment delivery, LWD levels, and stream channel function.
- Stream channel migration study of Nason Creek to assess the current channel confinement, the extent of the loss of channel migration and function, and the location of disconnected off-channel habitat (UCRTT 2001). The Yr. 2000 Chelan County Channel Migration Zone study should assist in this assessment to the extent it will incorporate the lower 4.0 miles of Nason Creek.
- Opportunities to and benefits of restoring disconnected oxbows given the existing limitations presented by the existence of the railroad grade and state Hwy's. 2 and 207 (UCRTT 2001).

#### *Nason Creek Watershed Project Recommendations*

- Protect remaining functioning floodplain and riparian habitat (UCRTT 2001).
- Restore channel migration, including reconnecting off-channel and floodplain areas, within the Nason Creek channel migration zone (UCRTT 2001).
- Provide fish passage from the wetlands and oxbows to Nason Creek that were cutoff because of State Highway 2 placement, from Whitepine Creek (RM 14.6 ) downstream to Kahler Creek (RM 5.1; UCSRB RTT 2001;MCMCP 1998).
- Develop riparian habitats in the right-of-way land along the state highway along lower Nason Creek (MCMCP 1998).
- Reduce sediment delivery from roads and minimize road building (USFS 1996).
- Reestablish vegetative communities on harvested upland habitat.

## WHITE/LITTLE WENATCHEE RIVER WATERSHED

### *White/Little Wenatchee River Watershed Description*

The 175,285 acre (USFS 1998c) White/Little Wenatchee River Watershed encompasses both the White River and the Little Wenatchee River drainages as well as Lake Wenatchee. The White and Little Wenatchee River drainages alone are 164,802 acres (C. Raekes, USFS, pers. comm., 2001). Watershed boundaries within Watershed Resource Inventory Area (WRIA) 45, the Wenatchee subbasin, are based on USFS Hydrologic Unit Code (HUC) 5<sup>th</sup> field levels as provided by the USFS in 2000. To allow for the presentation of information on the White and Little Wenatchee drainages and Lake Wenatchee in adequate detail, the White and Little Wenatchee drainages and Lake Wenatchee are discussed separately within this White/Little Wenatchee River Watershed section, following an overall description of the White/Little Wenatchee River watershed and general fish use within the watershed.

The White and the Little Wenatchee rivers are the two primary tributaries to Lake Wenatchee, flowing into the Lake at its western end. Combined with inflow from the Nason Creek Watershed at the mouth of Lake Wenatchee, the Nason Creek and White/Little Wenatchee River watersheds form the Wenatchee River. The watershed varies in elevation from 1,868 ft at the lake surface to 8,575 feet at Clark Mountain in the White River drainage. Land ownership is 97% public land and 3% private. Of the publicly-owned land, 61% is wilderness, 22% Late-Successional Reserve, 7% Administratively Withdrawn (USFS 1998c).

The majority of precipitation falls during the winter months as snow while localized high intensity thunderstorms during summer provide some precipitation (USFS 1998m). Runoff peaks during late May and early June as snowmelt progresses. Analysis shows that the difference between bankfull and lower frequency events is not as large as the difference in flashier systems in drier areas of the Wenatchee subbasin. This suggests that the White/Little Wenatchee River Watershed is better at storing water, at least temporarily. It also reflects the higher annual precipitation in this area of the subbasin (USFS 1998m). The White/Little Wenatchee River Watershed contributed 40% of the annual flow to the Wenatchee River (White River 25% and Little Wenatchee River 15%) for the period October 1992 – September 1993 (CCCD 1996). Annual precipitation varies from 30 inches at Lake Wenatchee to upwards of 140 inches in the headwaters of the White River; 90 inches in the headwaters of the Little Wenatchee River (USFS 1998m).

The watershed can be stratified into three distinct geomorphic groups. In the headwaters of both drainages there are glacial troughs and cirques with steep, rocky slopes rapidly delivering runoff to lower slopes. Further downstream, the glaciated mountain slopes are prominent, particularly in the Little Wenatchee River drainage. These slopes form the sides of the U-shaped glacial valleys that carry the Napeequa (a tributary to the White River), White, and Little Wenatchee rivers and generally have a layer of glacial till, bisected by numerous, poorly defined intermittent or perennial streams. Both the White

and Napeequa rivers are glacial, and transport glacial flour in the summer. The landtypes that make up this geomorphic group are commonly associated with debris flows and high surface runoff. Finally, the valley bottoms, filled with glacial till in the form of alluvial fans and lateral moraines, comprise the lower sections. Landtypes in this geomorphic group generally have a high subsurface water storage capacity and are commonly subject to inundation during high flow events. In sections where the stream is actively migrating across its floodplain, bank erosion is common at meander bends. Stream migration occurs regularly in the lower White and Little Wenatchee rivers where the valley bottom is low gradient and wide, the substrate is glacial till, and therefore channels have naturally high sinuosities (Rosgen C type channel; USFS 1998m).

Table 9 below, describes current, known salmon, steelhead, and bull trout use in the White/Little Wenatchee River watershed. Summer chinook use does not occur above the mouth of Lake Wenatchee (RM 54.2). Spring chinook, steelhead/rainbow, sockeye and bull trout spawn in both watersheds. The Little Wenatchee Falls (RM 7.8) is a known barriers to upstream migration for spring chinook and sockeye salmon and an assumed barrier to steelhead. There have not been any reports of bull trout above the falls with the exception a single bull trout individual being observed in Rainy Creek on two different occasions (K. MacDonald, USFS, pers. comm., 2001). Rainy Creek flows into the Little Wenatchee River at RM 8.4. The White River Falls (RM 14.3) is a known barrier to upstream migration for spring chinook, sockeye salmon, steelhead, and bull trout. Rainbow trout are distributed throughout the White and Little Wenatchee River systems above the falls and in some tributaries above the falls. Brook trout occur throughout the mainstem Little Wenatchee River up to Meander Meadow (RM 22.5) and in Rainy Creek, which enters the Little Wenatchee above the natural falls, at RM 7.9. Brook trout have not been documented above the White River Falls, however there are reports of brook trout in the Napeequa River, a tributary to the White River which enters at RM 11.0 (USFS 1998c). Lake Wenatchee is the nursery for the Lake Wenatchee sockeye salmon population; it also supports maturing adfluvial bull trout and migrating adult and juvenile bull trout, spring chinook salmon, and steelhead trout. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 9: Current, known salmon, steelhead, and bull trout use in the White/Little Wenatchee River watershed.**

White/Little Wenatchee River Watershed	Spring Chinook			Summer Chinook			Steelhead/Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
White River	X	X	X				X	X	X	X	X	X	X	X	X
Sears Creek														X	
Canyon Creek														X	
Napeequa River	X	X	X				X	X	X	X	X	X			X
Panther Creek	X						X	X					X	X	X
Little Wenatchee River	X	X	X				X	X	X	X	X	X	X	X	X
Rainy Creek													X	X	X
Lake Wenatchee			X						X		X	X		X	X

*White River Drainage*

White River Drainage Description. The White River drainage is a larger drainage than the Little Wenatchee River, encompassing 99,956 acres. It originates in alpine glaciers and perennial snow fields higher in elevation and further north than the Little Wenatchee drainage, thus it receives more precipitation in the form of snow, sustaining higher flows and cooler temperatures than the Little Wenatchee. The White River flows south-southeast for the majority of its length (26.7 river miles; Mullan et al. 1992), with two large tributaries that support anadromous salmonids; Napeequa (RM 11.0) and Panther (RM 13.1) creeks. Sears (RM 7.7) and Canyon (RM 10.0) creeks, two smaller tributaries to the White River, are known to support bull trout only. Of the total acreage in the drainage, 78% is in public ownership and 22% in private ownership, all in the lower third of the river below Panther Creek (USFS 1998m). The upper 15 miles of the White River are located entirely within the Glacier Peak Wilderness.

Precipitation ranges from 30 inches at the mouth to more than 140 inches in the headwaters. Bankfull flow (1.5 year return event) for the White River is approximately 3500 cfs. A 100 year return event is 9700 cfs based on a correlation between White River and Wenatchee River discharge or 14,300 cfs based strictly on USGS peak flow data for the period 1955 – 1983. When the 1980 peak flow is removed from the USGS data, the 100 year return event flows are similar (USFS 1998m). Peak flow recorded for the White River in December 1980 was 19,100 cfs. Elevation ranges from 1872 feet at the mouth of the White River to 8576 feet on Clark Mountain.

White River Drainage Discussion of Hydrogeomorphology and Habitat Conditions. Table 9 describes current known salmon, steelhead, and bull trout use in the White River drainage. The predominantly private-owned lower White River from Panther Creek (RM 13.1) to its mouth, is generally characterized as a deep, meandering channel developed in the deep glacial till of the broad valley bottom (Rosgen C channel types). The river is slightly entrenched and dominated by sand and gravel substrates. Rosgen C channel types are very sensitive to shifts in both vertical and lateral stability caused by direct channel disturbance and changes in flow and sediment regimes. The old-growth cedar stands in the valley bottom riparian zones have been converted to pasture and second growth cottonwood, resulting in an overall decline in bank stability and LWD recruitment. This is in addition to what can be expected in a channel type that is naturally subject to fluctuations in sediment loads and lateral channel adjustments as sediment and LWD are moved through the system. There is still tremendous LWD storage in the oxbows and side channels however, and some appears to be remnants from the cedar log drives. Associated with the development and pasture conversion in the lower White River valley bottom, drainage ditches have been constructed (RM 1.5) to drain wet floodplain for pasturing and perhaps flood control and LWD is still believed to be below historic levels (USFS 1998m). The lack of large-sized LWD input from the floodplain has likely contributed to a shorter, straighter channel today (USFS 1998m).

All four of the tributaries to the White River known to support chinook salmon, steelhead or bull trout (Panther Creek/RM 13.1, Napeequa River/RM 11.0, Canyon Creek/RM 10.0, and Sears Creek/RM 7.7) drain into the lower 13 mile reach of the White River. Of these streams, only the Napeequa River is reported to be impaired and only in its lower two miles where the Napeequa flows west through a widening valley into the very broad floodplain of the White River. Historic land clearing at the present day Tall Timber Ranch at the Napeequa and White Rivers' confluence, along with management practices, have negatively impacted channel processes at this location (USFS 1998m).

The upper White River from Panther Creek to its headwaters (RM 26.7) is generally characterized as a moderately entrenched channel dominated by rapids with irregular spaced scour pools. Streambed material tends toward coarse material (i.e. cobble) and bedrock, and bed and bank materials are considered stable (Rosgen B channel types; USFS 1998m). There is one section of river from approximately RM 15.0 to Thunder Creek (RM 21.7) that is characterized by a wider, meandering channel, the result of an alluvial fan impoundment (Rosgen C channel type; USFS 1998m). In the upper White River, debris slides and the fans associated with them have been and will continue to be the dominant process influencing the mainstem river (USFS 1998m). Moving upstream, the increasing density of small streams draining the steep valley walls increase the delivery of sediment and debris to the valley floor. This creates frequent alluvial fans causing major stream confinement with little sinuosity. In the lower reaches of the upper White River, alluvial fans are less frequent and influence channel alignment by forcing the river back and forth across the valley bottom creating broad sweeping turns. The upper White River is now located entirely within the Glacier Peak Wilderness and remains nearly pristine.

White River Drainage Current Known Habitat Conditions. The following listed information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### Access to Spawning and Rearing

#### Obstructions

(natural barriers are also provided here)

White River (45.1116). At RM 14.3 there is a natural falls that is a barrier to upstream fish passage.

Sears Creek (45.1121). At RM 0.37 there is a culvert that is a barrier to fish passage (USFS Culvert Barriers database, 2000). The USFS 2001 White River restoration project is currently removing culverts on Sears Creek Road (C. Raekes and D. Driscoll, USFS, pers. comm., 2001).

Napeequa River (45.1138). At RM 2.2 there is a 15 foot waterfall that is a natural barrier to upstream fish passage.

Panther Creek (45.0717). At RM 0.7 there is a series of 30 to 40 feet waterfalls that are a natural barrier to upstream fish passage.

#### Screens and Diversions

White River (drainage-wide). There are 14 surface water rights permits, certificates or claims located within the White River drainage filed with DOE (Montgomery Water Group et al. 1995). The status of the diversions and screens associated with the surface water rights are unknown at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### Riparian Condition

White River. In the lower White River (from the mouth upstream to the Napeequa River confluence at RM 11.0), historic logging and land clearing has impacted the riparian habitat. Over 2,000 floodplain acres (predominantly private ownership) were cleared of

old-growth cedar and converted to pasture land. Second-growth black cottonwood and mixed coniferous species are now intermingled with the pasture land. Since the mid-1980's, this second-growth component has been whittled away as development on private land continues (USFS 1998c). Roads in riparian areas also contribute to loss of riparian habitat function in the lower White River downstream of RM 11.0 (USFS 2001).

Napeequa River. There are section of rip-rap and/or bank erosion associated with roads, bridges, dispersed recreation, or other development along the lower Napeequa River. These individual sites however, comprise a low proportion of the entire streambank, and are not considered to be having a significant impacts on the system's functionality overall (USFS 1998c).

### Channel Conditions/Dynamics

#### Streambank Condition

White River. Sections of the White River have been rip-rapped and/or active bank erosion is evident associated with roads, bridges, dispersed recreation, or other development. Two notable locations include the stream banks located on private land adjacent to the County-owned White River Road bridge and riprap sections along the shorelines of the Napeequa Campground. These individual sites however, comprise a low proportion of the entire streambank, and are not considered to be having a significant impacts on the system's functionality overall (USFS 1998c).

Napeequa River. There are section of rip-rap and/or bank erosion associated with roads, bridges, dispersed recreation, or other development along the lower Napeequa River. These individual sites however, comprise a low proportion of the entire streambank, and are not considered to be having a significant impacts on the system's functionality overall (USFS 1998c).

#### Floodplain Connectivity

White River. During major flood events, the White River county road at RM 1.0 may alter flood flows at the crossing, however the impact is not considered to be significant (TAC 2001).

White River. Floodplain development has occurred below the Panther Creek (RM 13.1) confluence. This includes evidence of ditching to promote drainage in the floodplain and observed isolation of the channel from oxbows and other wetlands. The isolation of old oxbows may well be natural but there is a substantial risk of floodplain development as evidenced by the reality signs (USFS 1998c). The rest of the watershed largely remains hydrologically connected to its historic floodplain based upon aerial photograph analysis (USFS 1998c) and is judged to be functioning appropriately.

White River. Nearly half of the drainages' road miles are located in its floodplain (USFS 1998c).

White River. The Napeequa Campground (RM 11.0), consisting of five sites, is located within the floodplain between the river and the F.S. 6400 road, on the east side of the White River just below its confluence with the Napeequa River. Riprap has never been placed along the banks of the campsites. The primary concern is the reduction of floodplain connectivity, reduced channel migration with a subsequent reduction in LWD input, and reduced shade. The USFS management strategy is to not relocate the campground if it becomes flooded again (USFS 1998c).

#### Width/Depth Ratio

White River. Analysis of historical aerial photographs of the White River to the present shows that a large pulse of bedload has slowly been migrating down the White River since at least the 1940's. This is a natural, channel-changing process. The pulse is now downstream of the confluence with Panther Creek (RM 13.1) currently running into the Napeequa River confluence (RM 11.0; M. Karrer, USFS, pers. comm., 2001). The bedload deposit may be contributing to the high width/depth ratios in the White River within this reach. The source of the sediment is unknown (USFS 1998c).

#### Entrenchment Ratio

There are no concerns in the drainage with human-induced channel incision.

#### Habitat Elements

##### Channel Substrate

No information available.

##### Large Woody Debris

White River. Downstream of the Panther Creek confluence (RM 13.1), LWD levels on the White River are low. Between Napeequa (RM 11.0) and Panther Creek (RM 13.1), LWD abundance may be below its historic condition (USFS 1998c). Low LWD abundance in White River between Napeequa and Panther may be related to historic, harvest of riparian old-growth cedar along the White River, which removed essentially all old-growth cedar (USFS 1998c).

Napeequa River. Large woody debris amounts on the Napeequa River below the falls (RM 0.0 – 2.2) may be below its historic condition for LWD abundance due to historic cedar logging and private development in the valley bottoms (USFS 2001; USFS 1998c).

### Pool Frequency

White River. Pool frequency in the White River between Napeequa (RM 11.0) and Panther Creek (RM 13.1) may be low for its channel type (69% riffle habitat; USFS 1998c). Historic log drives and a large sediment pulse may have contributed to this condition (USFS 2001). This may be related to low LWD values, high width/depth values, and altered riparian condition in this portion of the White River (USFS 1998c).

### Pool Depth

White River (drainage-wide). Pool depth and pool quality is considered appropriate for all streams in the White River drainage. (USFS 1998c).

### Off-Channel Habitat

White River. In the lower White River (from the mouth upstream to the Napeequa River confluence at RM 11.0), historic logging and land clearing has impacted the riparian habitat. Over 2,000 floodplain acres (predominantly private ownership) were cleared of old-growth cedar and converted to pasture land. Second-growth black cottonwood and mixed coniferous species are now intermingled with the pasture land. Since the mid-1980's, this second-growth component has been whittled away as development of floodplains on private land continues (USFS 1998c). However, overall, the White River still has abundant, good quality, side channel habitat and also excellent oxbow habitat in the floodplain of the lower reaches ( USFS 1998m).

### Water Quality

#### Temperature

No apparent concerns with water temperatures.

#### Fine Sediment

No apparent concerns with fine sediments.

### Water Quantity

#### Dewatering

There are no known areas of dewatering, natural or human-induced, in the drainage.

### Change in Flow Regime

White River Drainage-wide. There are 9 surface water rights permits or certificates worth a potential total diversion of 0.9 cfs. There are 5 surface water rights claims worth a

potential total diversion of 3.4 cfs. There is one pending application for a surface water rights permit, certificate, or claim worth 0.1 cfs. There is 1 groundwater rights permit or certificate worth a potential total withdrawal of 350 gpm. There are 2 groundwater rights claims worth a potential total withdrawal of 18 gpm. There is 1 application for a groundwater rights permit, certificate or claim pending worth a potential total of 661 gpm (Montgomery Water Group et al. 1995). The limited extent of potential water diversions and withdrawals described above does not have the ability to change the flow regime of the mainstem or tributaries.

White River Drainage Fish Distribution and Use. Table 9 describes current known salmon, steelhead, and bull trout used in the White River drainage. The lower White River is one of two main spawning areas for the Lake Wenatchee sockeye run; the other being the lower Little Wenatchee River (USFS 1998m; MCMCP 1998). Most of the sockeye spawning for the entire Lake Wenatchee sockeye run occurs in the White River below the White River Falls (RM 14.3; USFS 1998m; MCMCP 1998) with the principal spawning area from RM 4.8 – 9.0 (MCMCP 1998). Sockeye also spawn from the mouth upstream to the barrier falls (RM 2.2) on the Napeequa River, a tributary to the White River (MCMCP 1998; WDF/WDW 1993).

The White River below the falls (RM 0.0 – 14.3) appears to be the spawning and rearing stronghold of Lake Wenatchee bull trout (MCMHP 1998b; Brown 1992). Bull trout also occur in tributaries to the White River. A bull trout parr was observed downstream of the USFS Rd. 6404 bridge in Sears Creek (RM 7.7) in 1989 (Brown 1992); a bull trout fry and a parr were observed in Canyon Creek (RM 10.0) downstream of the USFS Rd. 6404 (Brown 1992). Bull trout are believed to spawn in the Napeequa River (RM 11.0), another tributary to the White River, although this has not been confirmed (Brown 1992; USFS 1998m). The SaSI Bull Trout and Dolly Varden Appendix (WDFW 1998) states that the Napeequa River bull trout population is thought to be extinct, however large bull trout have been observed in the Napeequa River downstream of the natural falls at RM 2.2 (K. MacDonald, USFS, pers. comm., 2001). Panther Creek, a tributary entering the White River entering at RM 13.1, appears to support the largest numbers of known bull trout spawning (by redd count) of all the tributaries to the White River (Brown 1992). Bull trout are known to spawn and rear in Panther Creek both downstream of a natural falls at RM 0.7 (Brown 1992; Ringel 1997b; MCMCP 1998; USFS 1998m) and upstream of the RM 0.7 barrier. Spawning bull trout have also been observed in an unnamed tributary to Panther Creek which enters at RM 2.5. It is the first unnamed tributary entering Panther Creek from the south and upstream of the Ibex Creek confluence (S. Bickford, Douglas County PUD, pers. comm., 2001). Adult bull trout have also been observed in Indian Creek (RM 17.9), a tributary upstream of White River falls (RM 14.3), however spawning activity was not observed (S. Bickford, Douglas County PUD, pers. comm., 2001).

Spring chinook spawning occurs from the mouth of the White River upstream to the White River Falls, although the primary spawning area is between Sears Creek (RM 7.7) and the falls (RM 14.3). From 1958 to 1999, 6.73% of all redds located in the Wenatchee

subbasin were found in the White River between Sears Creek and the falls (Mosey and Murdoch 2000; Appendix C – Summarized spring chinook redd counts 1958-1999).

Steelhead trout spawn and rear in the White River up to the falls (USFS 1998m), in the Napeequa River up to its falls (RM 2.2) and in Panther Creek up to its falls (RM 0.7). Brook trout have been reported to occur in the Napeequa River although this has not been confirmed (USFS 1998m).

White River Drainage Summary. Relative to other watersheds in the Columbia basin, the White River drainage is among the healthiest, however a few moderate habitat concerns exist (USFS 1998m). Primarily, existing, functioning floodplain and riparian habitat needs to be protected to allow for continued full function, especially recruitment and accumulation of LWD and formation and maintenance of off-channel habitat. Also, where past timber harvest and rural/residential development (including road infrastructure) in the lower White River have reduced LWD recruitment and confined channel migration, restoring connectivity with disconnected wetland and floodplain habitat would improve channel function. From Panther Creek (RM 13.1) downstream to the mouth, the proper functioning riparian buffer width would be from the toe-of-slope to the toe-of-slope. This zone allows for channel migration within the large floodplain and associated wetlands, side channel development, and woody debris input (USFS 1998m). A loss of habitat-forming channel processes in the lower reach results in a decrease in the habitat components that contribute to salmonid survival and reproductive success. Because the lower White River is critical to maintaining one of the strongest remaining sockeye runs in the lower 48 states (also one of only two viable sockeye runs in the Columbia basin; USFS 1998m), and critical to maintaining a spawning adfluvial bull trout population in the White/Little Wenatchee Watershed, protecting functioning floodplain and riparian habitat in the lower White River is key to maintaining these two species in the White/Little Wenatchee Watershed.

#### *Little Wenatchee River Drainage*

Little Wenatchee River Drainage Description. The Little Wenatchee drainage is smaller than the White River, encompassing 64,794 acres. The headwaters of Little Wenatchee River are lower elevation, with more lakes and fewer glaciers. There are 13 lakes with a total area of 232 acres in the drainage (USFS 1998m). Little Wenatchee River flows approximately 22.7 (Mullan et al. 1992) river miles towards the southeast from the Cascade Crest into Lake Wenatchee. It is fed by four large tributaries (Rainy, Lake, Fish and Cady Creeks), although only the mainstem Little Wenatchee River supports anadromous salmonids and bull trout. However, on two different occasions, a single bull trout individual was observed in Rainy Creek (K. MacDonald, USFS, pers. comm., 2001). Of the total acreage in the drainage, 97% is publicly owned and 3% is in private ownership, all in the lower three miles. Roding is prevalent in the lower portions of the drainage from Lake Creek (RM 13.1) to the mouth (USFS 1998m). In Rainy Creek and in other heavily roaded and harvested portions of the Little Wenatchee watershed, debris flows appear to have been accelerated above background levels (USFS 1998m).

However, unroaded areas of the watershed were not inventoried for debris flows during the same period to allow for a comparison between roaded and unroaded areas of the watershed.

Annual precipitation ranges from 30 inches at the mouth of the Little Wenatchee River to 90 inches in the headwaters. Elevations range from 1872 feet at the mouth to 7063 feet on Mount Howard. Rains and snowmelt can lead to rapid runoff, leading to a somewhat flashy system (USFS 1998m).

Little Wenatchee River Drainage Hydrogeomorphology and Habitat Conditions. The Little Wenatchee River drainage differs from the White River in that its ridgetops and upper valley trough walls have shallow till deposits instead of bare bedrock. This resulted when glaciers from the Nason Creek drainage overrode the ridgetops into the Little Wenatchee drainage. The till deposits on the glaciated ridges have a high subsurface water storage giving rise to pot hole lakes and wet swales on the ridgetops. This storage capacity at the ridgetops effects valley bottom flow regulation and can contribute to a high mass wasting hazard (USFS 1998m).

The lower 1.3 miles of the Little Wenatchee River are heavily influenced by the backwater effects from Lake Wenatchee and have remained relatively stable (USFS 1998m). From RM 1.3 - 6.3, the river moves through a wide valley bottom covered in glacial till (C- type channel; Rosgen 1996), and is therefore highly sensitive to shifts in both vertical and lateral stability caused by both natural and human-induced direct channel disturbance, LWD distribution, and changes in flow and sediment regimes (USFS 1998m). Large LWD complexes that form between RM 3.5 and 6.3, which is the most dynamic segment of the Little Wenatchee River, are linked to slash piles from floodplain harvests prior to 1949, when the entire stream segment was partial cut to remove the old-growth cedars (USFS 1998m). Further downstream, (RM 1.3 – 3.5), sediment supply appears to have steadily increased, based on photos from 1949 - 1992, and is linked to channel widening and braiding in a few locations (USFS 1998m). This was in addition to what can be expected in a channel type that is naturally subject to fluctuations in sediment loads and lateral channel adjustments as sediment and LWD are moved through the system.

From RM 6.3 up to the Little Wenatchee Falls (RM 7.8), the river channel transitions from a wide, wetted valley bottom into a confined valley with increasing gradient dominated by rapids with a few scour pools. Above the falls to RM 12.7, large mass wasting events deliver sediment and debris to the valley bottom leading to relatively short reaches of depositional areas abruptly interrupted by sections of bedrock canyon. Continuing upstream, the channel remains confined with a large cobble and boulder substrate, and in places, deep bedrock gorges. Large woody debris is naturally low and the channel is very stable (USFS 1998m). The uppermost section of the Little Wenatchee River above Cady Creek (RM 26.5), is similar to the upper White River. Debris slides and the fans associated with them are the dominant process influencing this segment of the mainstem river (USFS 1998m). The increasing density of small streams draining the

steep valley walls increase the delivery of sediment and debris to the valley floor. This creates frequent alluvial fans causing major stream confinement with little sinuosity.

Degraded habitat conditions in the watershed include lower than expected LWD levels, concerns regarding possibly elevated sediment levels, and elevated instream temperatures recorded at the mouth of the Little Wenatchee River. Past logging practices included harvest in riparian areas, sometime leaving no buffer (prior to 1985), particularly from the mouth upstream to RM 16.9 (Cady Creek) along the Little Wenatchee River corridor and in the Rainy Creek subwatershed (USFS 1998c). Percent of subwatershed harvested is high in some areas of the watershed: 28 % of the Little Wenatchee corridor from the mouth upstream to Elevenmile Creek (RM 11.9); 18% of the Little Wenatchee River corridor from Elevenmile Creek to Cady Creek (RM 11.9 – 16.9); and 14% of the Rainy Creek subwatershed (USFS 1998m). Road densities in these portions of the watershed are also higher than preferred for “functioning appropriately” (<1 mi./sq. mi. with no valley bottom roads; USFWS 1998c); 2.4 mi./sq. mile in the Little Wenatchee River corridor from the mouth upstream to Cady Creek (RM 16.9); and 1.5 mi./sq. mi. in the Rainy Creek subwatershed and (USFS 1998m). Although there is still an old growth component in the floodplain, the dominant riparian vegetation size class within a 100 foot riparian buffer is shrub seedling and sapling pole (USFS 1998c). However, to date, the Little Wenatchee River drainage as a whole is considered to still be functioning although the species composition has changed (D. Driscoll and M. Karrer, USFS, pers. comm., 2001).

Rainy Creek enters the Little Wenatchee River at RM 8.4, just above the falls (RM 7.8), and is the only tributary to the Little Wenatchee River known to support bull trout (up to a natural barrier on Rainy Creek at RM 5.5). The barrier falls on the Little Wenatchee River is a complete barrier to anadromous fish. Rainy Creek is a high energy transport stream with steep gradients and a boulder/cobble bed alternating with bedrock. This equates to a very stable channel with a low sediment supply input from banks and a rapid transport of water, LWD and sediment received from higher up in the drainage. A large fan has built up at the mouth of Rainy Creek and the channel at the mouth has gone from three wetted channels down to one entrenched, very unstable channel. It is unclear what effect land management practices have had on debris slide regimes in the drainage or on the channel forming processes at the mouth (USFS 1998m). A bridge was constructed to cross Rainy Creek near its mouth and USFS Rd. 6700 follows the creek up to its headwaters crossing the stream three times.

Little Wenatchee River Drainage Current Known Habitat Conditions. The following listed information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

## Access to Spawning and Rearing

### Obstructions

(natural barriers are also provided here)

Little Wenatchee River (45.0985). At RM 7.8 there is a natural falls that is a barrier to upstream fish passage.

Rainy Creek (45.0998). At RM 5.5 there is a series of seven waterfalls and three chutes that create a barrier to upstream fish passage.

### Screens and Diversions

Little Wenatchee River Drainage. There are 3 surface water rights permits or certificates worth a potential total diversion of 1.0 cfs, located within the Little Wenatchee River drainage and filed with DOE (Montgomery Water Group et al. 1995). The effects of the diversions, both individual and cumulative, on instream habitat conditions are undetermined at this time. Uncertainties should be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### Riparian Condition

Little Wenatchee River. Some harvest has occurred in riparian areas, contributing to lowered LWD levels and possibly also contributing to elevated instream temperatures as detected at the mouth (USFS 1998m). Pre-1985, most of the older timber harvest units left no riparian buffer, particularly in the upper Little Wenatchee (RM 16.9 - headwaters), lower Little Wenatchee (RM 0.0 – 11.9) and Rainy Creek areas (USFS 1998c).

Rainy Creek. Pre-1985, most of the older timber harvest units left no riparian buffer, particularly in the upper Little Wenatchee (RM 16.9 - headwaters), lower Little Wenatchee (RM 0.0 – 11.9) and Rainy Creek areas (USFS 1998c).

Rainy Creek. There are some clearcuts directly adjacent to the creek where grazing/watering is allowed near the headwaters and tributary channel on the south side of Rainy Creek. These were documented during USFS 1998 photo monitoring (USFS 1998c). The USFS has determined that although soil disturbance was noted in these areas, it has only a very slight impact on fish habitat on a reach basis relative to shade reduction and is therefore insignificant (K. MacDonald, USFS, pers. comm., 2001).

## Channel Conditions/Dynamics

### Streambank Condition

Little Wenatchee River. In the vicinity of the Riverside Campground (RM 7.8) both banks of the river have been riprapped (USFS 1998c) for structure protection at the bridge and as a result of flood damage on the opposite side of the old Riverside Campground. This is not a developed campground but a dispersed one located in the floodplains along the north bank immediately above the falls. The riprap is not considered to be having a significant impact on the functionality of the reach nor on the river's functionality overall (TAC 2001).

### Floodplain Connectivity

Little Wenatchee River. In the last USFS Little Wenatchee River stream survey, there is no evidence of loss of floodplain connectivity. Overall, floodplain function within the watershed is considered to be functioning appropriately (USFS 1998c; USFS 2000).

Rainy Creek. The channel in the alluvial fan at the mouth has gone from three wetted channels down to one entrenched, very unstable channel. A bridge was constructed to cross Rainy Creek near its mouth and USFS Rd. 6700 follows the creek up to its headwaters crossing the stream three times. It is unclear what effect land management practices have had on debris slide regimes in the drainage or on the channel forming processes at the mouth (USFS 1998m).

### Width/Depth Ratio

Little Wenatchee River. The USFS biological assessment (USFS 1998c) reported that based on USFS analysis of historical aerial photographs, depositional reaches between RM 1.3 and 3.5 may be at risk for increasing width/depth ratios (USFS 1998c).

### Entrenchment Ratio

Rainy Creek. The channel in the alluvial fan at the mouth has gone from three wetted channels down to one entrenched, very unstable channel. A bridge was constructed to cross Rainy Creek near its mouth and USFS Rd. 6700 follows the creek up to its headwaters crossing the stream three times. It is unclear what effect land management practices have had on debris slide regimes in the drainage or on the channel forming processes at the mouth (USFS 1998m).

## Habitat Elements

### Channel Substrate

Little Wenatchee River. Upstream of the falls at RM (7.8), there was evidence of pool filling and spawning gravel embeddedness during the 1997 USFS stream survey (USFS 1998c).

Rainy Creek. According to the 1991 USFS stream survey report for Rainy Creek, visual estimates showed a high percent embeddedness below the barrier falls (RM 5.5). High and possibly accelerated rates of debris flows (1996 slide survey), extensive timber harvest, and road placement may result in accelerated sediment delivery to the stream (USFS 1998c). Road densities in Rainy Creek are 1.5 miles/sq. mile (USFS 1998m). However, it is the opinion of the TAC that in the past 10 years a lot could have changed in the watershed and a more current review and analysis of sediment conditions in Rainy Creek is needed.

### Large Woody Debris

Little Wenatchee River. A stream survey conducted in 2000 concluded that LWD levels below RM 7.8 indicated the reach was functioning appropriately for LWD (USFS 2000). During the 1970's, biologists concerned that large LWD complexes were anadromous barriers in the lower few miles of the river, made several attempts to remove them, however they kept rebuilding in the same location (Mullan et al. 1992; USFS 1998m).

### Pool Frequency

All streams in the Little Wenatchee River watershed appear to be within the range of natural conditions for pools (USFS 1998c).

### Pool Depth

Little Wenatchee River (drainage-wide). Pool depth and pool quality is considered appropriate for all streams in the Little Wenatchee River drainage. Although pool filling and embedding is occurring in depositional reaches of Little Wenatchee River above the falls (RM 7.8), many deep pools still remain (USFS 1998c).

### Off-Channel Habitat

Rainy Creek. Except for the alluvial fan area at the mouth, Rainy Creek is a steep, transport channel. However, at the mouth, the channel has gone from three wetted channels down to one entrenched, very unstable channel. A bridge was constructed to cross Rainy Creek near its mouth and USFS Rd. 6700 follows the creek up to its

headwaters crossing the stream three times. It is unclear what effect land management practices have had on debris slide regimes in the drainage or on the channel forming processes at the mouth (USFS 1998m).

### Water Quality

#### Temperature

Little Wenatchee River (45.0985). The Little Wenatchee River below Theseus Creek (RM 11.5) does not meet state and forest plan water quality standards during the summer months (USFS 1998c). Water temperature exceeded 61 °F for several weeks in August 1997; water temperature exceeded 61 °F in 4 of 5 recorded years (USFS 1998c). The Little Wenatchee River from the mouth to the headwaters is on the 303(d) list for temperature (WDOE 1998). However, there is presently not enough data to determine if these temperatures are significantly different than temperatures in the historic range for the (D. Driscoll, USFS, pers. comm., 2001) or to what extent, if any, these temperatures negatively impact salmonid migration, spawning, incubation or rearing. The USFS has initiated an analysis of instream temperatures on the Little Wenatchee River to evaluate the effects on salmonids.

#### Fine Sediment

Little Wenatchee River. Road densities in the Lower Little Wenatchee subwatershed (RM 0.0 - 11.9) and the Upper Little Wenatchee subwatershed (RM 16.9 to the headwaters) are both 2.4 miles/sq. mile (USFS 1998m). The NMFS and the USFS criteria (USFWS 1998c) rates road densities of 1 – 2.4miles/sq. mile with some valley bottom roads, as “functioning at risk”. There is some evidence of pool filling and spawning gravel embeddedness during the 1997 USFS stream survey conducted above the falls at RM 7.8 (USFS 1998c) in some surveyed reaches, however, there is presently not enough information to determine if fine sediment is a concern.

Rainy Creek. Multiple visual estimates of embeddedness below the natural falls barrier at RM 5.5 were >35 % by volume. High and possibly accelerated rates of debris flows (1996 slide survey), extensive timber harvest, and road placement may result in accelerated sediment delivery to the stream (USFS 1998c). Road densities in Rainy Creek are 1.5 miles/sq. mile (USFS 1998m).

There are also some clearcuts directly adjacent to the creek where grazing/watering is allowed near headwaters and mid-slope at tributary channels on the south side of Rainy Creek. These were documented during USFS 1998 photo monitoring. The USFS has determined, based on 1998 monitoring, that sediment impacts from soil disturbed by grazing may contribute slight but measurable amounts of fine sediment to the channel system. The USFS has determined this is not significant on a reach basis (USFS 1998c). However, it is the opinion of the TAC that in the past 10 years a lot could have changed

in the watershed and a more current review and analysis of sediment conditions in Rainy Creek is needed.

### Water Quantity

#### Dewatering

There are no known areas of dewatering, natural or human-induced, in the drainage.

#### Change in Flow Regime

Little Wenatchee River (drainage-wide). There are 3 surface water rights permits or certificates worth a potential total diversion of 1.0 cfs. There are no surface water claims or applications. There are no groundwater rights permits, certificates, claims or applications. (Montgomery Water Group et al. 1995). The limited extent of potential water diversions described above does not have the ability to change the flow regime of the mainstem or tributaries.

Little Wenatchee River. Although there is no historic annual flow record in the Little Wenatchee watershed, because of substantial road network and timber harvest below the wilderness boundary (approximately RM 9.5), combined with apparent pool filling and an increasing width/depth ratio in the lower depositional reaches, the Little Wenatchee River flows may be altered from a naturally functioning condition (USFS 1998c).

Little Wenatchee River Drainage Fish Use and Distribution. Table 9 describes current known salmon, steelhead, and bull trout use in the Little Wenatchee River drainage. The lower 8 miles of the Little Wenatchee River is one of two main spawning areas for the Lake Wenatchee sockeye run; the other being the lower White River (USFS 1998m; MCMHP 1998b). The lower Little Wenatchee River below the falls (RM 7.8) provides important spawning habitat for approximately 25% of the Lake Wenatchee sockeye salmon run (USFS 1998m).

There is spawning and rearing of adfluvial bull trout in the Little Wenatchee River below the falls (USFS 1998m). Although there have been attempts to confirm bull trout spawning above the Little Wenatchee River falls, no bull trout were reported above the falls until 1996 when one bull trout was observed in Rainy Creek, a tributary entering the Little Wenatchee River above the falls at RM 8.4. In 1997 another bull trout was observed in Rainy Creek. The fish were relatively small, approximately 12 inches, so it was not possible to determine whether the individuals were resident fish or juveniles from a migratory population below the falls. Because connectivity between a possible population in Rainy Creek and the rest of the watershed is uncertain given the falls downstream on the Little Wenatchee River, and because there is a high abundance of brook trout in Rainy Creek and the Little Wenatchee River, it is doubtful that a healthy bull trout population exists in Rainy Creek (USFS 1998m).

Spring chinook and steelhead trout spawn and rear in the Little Wenatchee River upstream to the falls, with the primary spawning area for spring chinook between RM 2.7 and RM 7.8 (Chelan County spawning ground surveys; USFS 1998m). Chelan PUD spring chinook redd counts from 1958 to 1999 showed the Little Wenatchee watershed contained 7.07% of the total number of redds counted in the Wenatchee subbasin for that period (Appendix C – Summarized spring chinook redd counts 1958-1999). There have been extensive planting of rainbow and brook trout in most lakes and streams in the Little Wenatchee drainage to the extent that brook trout have become very well established in the lower Little Wenatchee River, in Rainy Creek and in other streams in the drainage (USFS 1998m).

Little Wenatchee River Drainage Summary. Relative to other watersheds in the Columbia basin, the Little Wenatchee River is among the healthiest, however a few moderate habitat concerns exist (USFS 1998m). First, protection of existing floodplain and riparian habitat to maintain the present level of functionality should be given the highest priority. Habitat restoration should be the second priority, focusing first on decreasing road densities and impacts from roads, and second, on rehabilitating riparian areas (USFS 1998m). Most of the habitat concerns occur in and below areas of extensive timber harvest (USFS 1998m). The Little Wenatchee River corridor from the mouth upstream to Cady Creek (RM 0.0 - 16.9) and the Rainy Creek drainage have experienced the brunt of timber harvest activities and road development impacts. Timber harvest and road development have decreased LWD input, increased sediment delivery, and disrupted the delivery pattern of debris to the channels from debris slides. High road densities and harvest activities may also contribute to high stream temperatures in the mainstem Little Wenatchee River by increasing runoff and decreasing water storage potential.

### *Lake Wenatchee*

Lake Wenatchee Description. Lake Wenatchee is a deep, alpine lake located in the upper Wenatchee subbasin. Its outflow forms the head of the Wenatchee River, 54.2 river miles upstream from the confluence of the Wenatchee and Columbia Rivers. The White and Little Wenatchee Rivers deliver most of the inflow, having a combined drainage area of 175,285 acres with the total drainage area of Lake Wenatchee being 10,870 acres. A handful of small tributaries also flow into the lake along the north and south shores. Lake Wenatchee, at an altitude of 1868 feet is approximately 5 miles long (13 miles of total shoreline) with a surface area of 2500 acres. It has an average depth of 150 feet and a maximum depth of 240 feet. A large wetland complex occurs at the inlet (southwestern end) to this free-flowing, oligotrophic lake, which is termed classic sockeye rearing habitat; cold, well-oxygenated, with low productivity. North Shore Drive parallels the north lake shore and State Highway 413/ USFS Rd. 6607 parallel two-thirds of the south shore. Various campgrounds, two public boat launches, and lake shore homes dot the shorelines.

Lake Wenatchee Discussion of Hydrogeomorphology and Habitat Conditions. Currently, little information has been collected on fish habitat conditions on Lake Wenatchee, however a water storage feasibility study for the lake was initiated in September 2001. The state legislative grant for the study is being administered by Chelan County through its Watershed Program, and has the potential to contribute to the knowledge base for Lake Wenatchee. To date, research on Lake Wenatchee has focused primarily on the Lake Wenatchee sockeye salmon stock and the lake's biological productivity relative to sockeye productivity. Data that has been collected has focused on water quality parameters and food production. The U.S. Geological Survey (USGS) has mapped the lake depths and from 1935 until 1971 maintained a lake-stage recorder (Dion, et al. 1976). The USFS Mainstem Wenatchee Watershed Assessment (USFS 1999c) contains limited information on Lake Wenatchee and its habitat. Analysis to date indicates that in Lake Wenatchee the survival bottleneck for sockeye salmon, including evaluation of hydro system passage impacts and ocean survival, is early rearing, given the naturally low biological productivity of Lake Wenatchee (Mullan 1986; Chapman et al. 1995b). Mullan (1986) reported that oligotrophic lakes are most sensitive to disturbances but that the environment and species diversity of ultraoligotrophic Lake Wenatchee are little altered from primordial times, and the lake retained a high efficiency in converting a low nutrient base to sockeye production. However, analysis of the potential impacts to sockeye and the other salmonids (especially bull trout) inhabiting the lake, from increasing shoreline development for recreation, housing, and associated infrastructure on lake water quality has not been evaluated.

Lake Wenatchee Current Known Habitat Conditions. The following listed information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### *Access to Spawning and Rearing*

#### Obstructions

(natural barriers are also provided here)

There are no barriers to salmonid migration on Lake Wenatchee. Both the outlet and inlet are free flowing.

#### Screens and Diversions

No information available.

Riparian Condition

Shoreline development has increased in past years and continues to be a concern regarding loss of functioning riparian habitat.

Channel Conditions/Dynamics

Streambank Condition

Shoreline development has increased in past years and continues to be of concern regarding impacts to shoreline conditions. Bulk heads construction and loss of functioning riparian habitat negatively impact lake shore conditions to an undetermined extent.

Floodplain Connectivity

No information available.

Width/Depth Ratio

Not applicable.

Habitat Elements

Channel Substrate

No information available.

Large Woody Debris

No information available.

Pool Frequency

Not applicable.

Pool Depth

Not applicable.

Off-Channel Habitat

No information available.

Water Quality

### Temperature

No information available.

### Fine Sediment

No information available.

### Water Quantity

### Dewatering

Not applicable.

### Change in Flow Regime

No information available.

Lake Wenatchee Fish Use and Distribution. Table 9 describes current known salmon, steelhead, and bull trout use in the Lake Wenatchee drainage. Lake Wenatchee is the nursery lake for the Wenatchee subbasin sockeye run. The lake also supports maturing adfluvial bull trout, providing refugia from disturbance, drought, and temperature extremes, over-wintering habitat, and an excellent food source. Adult and juvenile fluvial bull trout, spring chinook salmon, and steelhead trout migrate through the lake, and in the spring of 2001, the Yakama Nation (YN) released coho smolts into the lake as part of YN coho reintroduction program. Summer chinook salmon do not occur upstream of the outlet of Lake Wenatchee. Salmonid spawning does not occur in the lake but in the White and Little Wenatchee rivers, tributaries to Lake Wenatchee, up to barrier falls on these streams (RM 14.3 and 7.8, respectively).

Lake Wenatchee Summary. Lake Wenatchee habitat is critical for supporting the Lake Wenatchee sockeye salmon stock and the Lake Wenatchee adfluvial bull trout population in the Wenatchee subbasin. Maintaining excellent connectivity between spawning grounds and the lake and between the lake and the Wenatchee River system is of primary importance. Of concern are impacts to shoreline habitat, shallow water habitat, and water quality which may negatively impact salmonid food production in the lake and escape cover for rearing juvenile sockeye.

### *White/Little Wenatchee River Watershed Summary*

Protection of functioning floodplain and riparian habitat is the highest priority in this watershed, including shallow water habitats and shoreline habitat of Lake Wenatchee. Loss of floodplain function on the White and the Little Wenatchee Rivers is the greatest threat to salmonid production in the White/Little Wenatchee Watershed. The White and the Little Wenatchee Rivers have among the best aquatic habitat and strongest native fish populations anywhere in the Columbia basin (USFS 1998m). The connectivity

between these two watersheds and other good aquatic habitat is also among the best in the Columbia basin. Their connectivity to a large undammed lake, Lake Wenatchee, also adds to their high regional value (USFS 1998m). The sockeye run which spawns in these two drainages is one of the strongest remaining in the lower 48 states, and only one of two sockeye runs remaining in the Columbia basin. Important populations of spring chinook, steelhead and bull trout also spawn and rear in these waters. Much of the reason for the high aquatic health of these watersheds is that in the depositional reaches near the mouth of both rivers, both the structurally complex, meandering channels and the broad, wetland-filled floodplains remain largely undeveloped, despite the presence of considerable private land.

Reducing the effects of road density and location in the Little Wenatchee River drainage is second in priority in the Little Wenatchee River drainage, with emphasis on Rainy Creek and the Little Wenatchee River from the mouth upstream to Cady Creek (RM 16.9), followed by restoring wetland connectivity and function in the vicinity of the Lake Wenatchee inlet. Additionally, harvest within riparian areas on the mainstem Little Wenatchee and Rainy Creek has further reduced potential LWD recruitment, altered runoff and water storage patterns, and increased fine sediment input into receiving waters. Restoring wetland connectivity and function is second to habitat protection in the White River drainage.

#### *White/Little Wenatchee River Watershed Data Gaps*

- Extent of the effects of timber harvest and road development in the Little Wenatchee River corridor and the Rainy Creek drainage, on stream channel function, water temperature, sediment delivery and transport, and LWD recruitment.
- Field habitat inventory and analyses are incomplete on private lands and on Lake Wenatchee.

#### *White/Little Wenatchee River Watershed Project Recommendations*

- Protect stream channel, floodplain and riparian function on the lower White River, focusing from the Panther Creek confluence downstream to the mouth (RM 0.0 – 13.1; UCRTT 2001; MCMCP 1998) and the Little Wenatchee River, focusing from the mouth upstream to the falls (RM 0.0 – 7.8; UCRTT 2001; MCMCP 1998).
- Restore wetland complexes throughout the watershed, that connect to the stream channel (UCRTT 2001).
- Decrease road densities in the Little Wenatchee River corridor and the Rainy Creek drainage (USFS 1998m).

- Restore riparian buffers along the Little Wenatchee River and Rainy Creek (USFS 1998m).
- Protect shorelines along Lake Wenatchee, particularly near the mouth of the White and Little Wenatchee Rivers.
- Reduce impacts to shallow water habitat in Lake Wenatchee.
- Identify the causal mechanisms for the developing channel instability at the mouth of Rainy Creek.
- Initiate public information efforts to discourage harassment of spawning spring chinook, sockeye salmon, and bull trout (UCRTT 2001).
- Manage recreation areas to reduce impacts to riparian cover (UCRTT 2001).

#### SQUILCHUCK CREEK WATERSHED (WRIA 40)

##### *Squilchuck Creek Watershed Description*

The headwaters of Squilchuck Creek lie in the upper reaches of Beehive Mountain, Mission Peak, the Naneum Ridge and Wenatchee Mountain. Squilchuck Creek flows 10.6 miles (USFS 1998j) in a northeast direction to its confluence with the Columbia River (Columbia RM 464.0), four miles downstream of the Wenatchee River confluence. Elevation ranges from 6800 along the southwest divide near Mission Peak to 653 feet at the mouth. There are approximately 18,167 acres (28.4 square miles) in the watershed with the first 9.0 miles of stream flowing through private or state land ownership (USFS 1998j). The upper 1.6 miles of Squilchuck Creek flow through USFS managed land. County Road 711 parallels the stream channel, crossing it twice. Mission Ridge Ski Area lies at the end of this road.

Average annual precipitation is about 28 inches in the headwaters (6000-foot elevation) with precipitation rapidly decreasing with declining elevation. The 4000-foot elevation averages about 25 inches, with the 3000-foot elevation averaging about 20 inches annually (USFS 1998j). Precipitation occurs predominantly as snow from October to February. Runoff comes predominantly from melting of accumulated snow; about 65% of the total annual water production occurs as snowmelt streamflow in April through July (USFS 1998j). Snowmelt should provide a total of 6400 acre feet of annual water production at the confluence of Squilchuck Creek and Miners Creek (RM 6.3, approximate elevation, 900 feet). Elevations below 3000 feet produce water but amounts are less significant due to aspect, vegetation, and rain shadow affect. Areas of the watershed below the elevation of 1500 feet do not produce streamflow except during rain, snow or thunderstorm events (USFS 1998j). Because of this seasonal distribution

of water supply, agricultural users have constructed water storage facilities for periods when competition for water increases in late summer and early fall.

The Squilchuck watershed is a very popular recreation area for both winter and summer. Winter is the heaviest use season when upwards of 100,000 visitors use the Mission Ridge Ski Area alone (USFS 1998j). The 2000 acres ski area opened in 1966, presently has 221 acres of cleared areas, and snowmaking is used to supplement snowfall on the lower mountain). Beehive Reservoir draws visitors during the summer months and also receives moderate amount of snowmobile use in the winter.

### *Squilchuck Creek Watershed Discussion of Hydrogeomorphology and Habitat Conditions*

Topography of the watershed is highly variable with sizeable areas of gentle topography, very steep slopes, numerous natural depressions, and vertical rock cliffs. Geologic processes included extensive erosion of underlying sediments and landslides and earth flows that resulted in talus slopes of the Rubbleland-Rock Outcrop type (USFS 1998j). Rubbleland-Rock formations have almost total infiltration so that rain and snowmelt water passes immediately into the fractured basalt and moves through the watershed as subsurface flow. Soils are also extremely permeable, formed when earth flows mixed angular basalt rock with underlying, weathered sandstone formations. Therefore, springs are numerous but usually surface and then disappear subsurface without developing significant wetlands. The majority of stream channels in the watershed are seasonal channels, carrying snowmelt runoff. The lower watershed (below Squilchuck State Park at RM 6.0) is dominated by these seasonal channels that flow during spring runoff or during high intensity summer thundershowers. Most of the channels are dominated by brush riparian areas, and sand/gravel substrates (USFS 1998j). No additional published information exists for the lower Squilchuck watershed relative to stream channel functions, however, the conversion of floodplain habitat within the alluvial fan to trailer park communities is evident (K. March, WDFW, pers. comm., 2001). Additional development within the channel migration zone of Squilchuck Creek includes road development, railroad development, and rural/residential and pasture land conversion. All of the areas downstream of the Squilchuck State Park (RM 6.0) is in private ownership. Fish passage barriers also exist in Squilchuck Creek: the Burlington Northern yard culvert at RM 0.1 is a partial barrier to fish passage (B. Heiner, WDFW Engineer, pers. comm., 2001), then the S. Wenatchee Avenue County Road culvert at RM 0.3 is a full barrier to fish passage (B. Steele, WDFW, pers. comm., 2001); multiple additional barriers have been identified upstream of RM 0.3 (Harza 2000).

Perennial streams are limited to the upper Squilchuck area and include Miners Run, Lake Creek and upper Squilchuck Creek above the Mission Ridge Ski Area chair 2 ski lift. Portions of Squilchuck Creek that flow under the chair 2 ski lift area go subsurface where it flows through rubble rock (USFS 1998j). These streams are steep gradient (>10%), boulder and cobble-dominated, stable channel types (Rosgen A and B type channels) confined by narrow canyons (USFS 1998j). The USFS surveyed the stream channels and draws on federally managed land in the watershed.

Although archeological records indicate human occupation along the Columbia River in the vicinity of Wenatchee dates back as far as 7,000 years, water was the element that drove Euro-human settlement in these arid lands of Washington in the 1800's (USFS 1998j). By the early 1800's, a water system for irrigation was in place to divert water from Squilchuck Creek to raise alfalfa for cattle and cultivate a few apple and peach trees. The demand for water soon outstripped the ability of Miller's Ditch, as it was known, so a second ditch, the Settler's Ditch, was soon constructed parallel to Miller's Ditch. It too diverted water from Squilchuck Creek and was dependent on adequate snowpack to provide a steady flow of water. The growing need for a greater volume of water soon led to the development of the Highline Canal to transport water from the Wenatchee River in lieu of relying on small water supplies in the side canyons (USFS 1998j). The storage of water in the upper Squilchuck watershed began as early as 1919 at the Beehive Reservoir site and with the H & H Reservoir, a small private reservoir supplying Pitcher Canyon. For want of more water to provide for irrigation in the upper Squilchuck, in the 1950's work began on a pipeline to route water from Lake Creek to Beehive Reservoir (20 acres). The storage of water over the winter usually provides an adequate supply for the Beehive Irrigation District shareholder, but in dry years the supply sometimes falls short (USFS 1998j). The Squilchuck watershed was adjudicated in 1926 with no provisions for maintaining instream flows; certified water rights appear to exceed available surface flow on an annual basis (J. Monahan, DOE, pers. comm., 2001).

#### *Squilchuck Creek Watershed Current Known Habitat Conditions*

The following listed information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represents the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but may instead indicate a lack of available information. All references to River Miles (RM) are approximate.

#### *Access to Spawning and Rearing*

##### Obstructions

(natural barriers are also provided here)

Squilchuck Creek (40.0836). The Burlington Northern yard culvert at RM 0.1 is a partial barrier to upstream fish passage. Washington Department of Fish and Wildlife Engineer, Bruce Heiner, stated that the culvert was very long, and during some flows, would not be passable to fish. (B. Heiner, WDFW Engineer, pers. comm., 2001). This was not surveyed during the county barrier inventory due to lack of permission to access the site (Harza 2000).

Squilchuck Creek (40.0836). At RM 0.3, the S. Wenatchee Avenue culvert (County Road) is a passage barrier to upstream migration (B. Heiner and B. Steele, WDFW, pers. comm., 2001). This was identified as an “unknown” barrier according to the WDFW Level A barriers inventory methodology (1998b) used by Harza (2000). However, a field evaluation of the culvert by a WDFW engineer in September 1999, indicated both velocity and outlet drop at the culvert created a barrier to upstream fish passage, particularly steelhead (B. Heiner, WDFW Engineer, pers. comm., 2001).

Squilchuck Creek. In the lower 9.0 miles, six fish passage barrier culverts were identified. The first two barriers are at RMs 1.3 and 2.9 on private drives off Squilchuck Road. (Harza 2000). The next three fish-blocking culverts are on Squilchuck Road at RMs 5.6, 5.8 and 7.9 (Harza 2000). The upper-most identified fish-blocking culvert is at RM 8.2 on Forest Ridge Drive (Harza 2000).

Squilchuck Creek. There is a culvert at the Wayhut Maintenance Road crossing in the Mission Ridge Ski area. There is no information regarding fish passage at the culvert.

Squilchuck Creek. There is a culvert under the Mimi ski run in the Mission Ridge Ski area. There is no information regarding fish passage at the culvert.

#### Screens and Diversions

Squilchuck Creek. The Beehive Irrigation District has a water right for diversion of 3cfs for a total storage of 300 acre feet of flow of Upper Squilchuck and Lake Creeks into Beehive Reservoir (USFS 1998j). Information on the location and condition of private water diversions are not available at this time. It is anticipated that this data gap will be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

#### Riparian Condition

Squilchuck Creek. The location of the railroad yard in the floodway is negatively affecting riparian function and habitat (B. Steele, WDFW, pers. comm., 2001).

Squilchuck Creek. Riparian areas in non-forested settings are dominated by red osier dogwood and cottonwoods except where private land owners have denuded the stream banks and removed cover from the stream (USFS 1998j).

Squilchuck Creek. In the vicinity of Mission Ridge Ski Area parking lot, the dominant vegetation is shrubs and grasses providing little to no shade with instream temperatures ranging from 42-45°F (USFS 1998j).

Squilchuck Creek. In the vicinity of the Tumwater Ski run, trees on the left bank have been removed fully exposing the stream (USFS 1998j). Also in this reach, tree cover and LWD appear to have been modified by grading of the Tumwater ski run (USFS 1998j). The Wayhut Maintenance Road (Mission Ridge Ski Area) which goes to Chair Lift 2, is also adjacent to the creek in this segment. Only a negligible potential source of sediment occurs from the Maintenance Road (USFS 1998j).

Squilchuck Creek. Upstream of the Tumwater Ski run, a reach of stream has been fully exposed as numerous riparian conifers were felled for unknown reasons many years ago (USFS 1998j).

### Channel Conditions/Dynamics

#### Streambank Condition

Squilchuck Creek. The lower 0.3 miles of the creek experiences significant scour (B. Steele, WDFW, pers. comm., 2001).

Squilchuck Creek. The banks adjacent to the Mission Ski Area parking lot are riprapped. The banks and stream in this location are littered with tires, batteries, cans and paper (USFS 1998j).

#### Floodplain Connectivity

Squilchuck Creek. The location of the railroad yard in the floodway is negatively affecting floodplain function (B. Steele, WDFW, pers. comm., 2001).

#### Width/Depth Ratio

No information available.

#### Entrenchment Ratio

No information available.

## Habitat Elements

### Channel Substrate

No information available.

### Large Woody Debris

Squilchuck Creek. There is no recruitment of LWD occurring in the first 0.3 miles of the creek. Instead there is human debris like wood pallets, refrigerators and garbage in the stream channel in this reach (B. Steele, WDFW, pers. comm., 2001).

Squilchuck Creek. Large woody debris is lacking in all channel segments within the Mission Ridge Ski area (USFS 1998j).

Squilchuck Creek. In Segment 9 , LWD has been extensively and negatively influenced by the Tumwater ski run. The only LWD found is in a depression created in the channel after it crosses the ski run (USFS 1998j).

Squilchuck Creek. In Segment 10, grading of the Tumwater ski run may have altered the natural channel characteristics of a portion of the left bank by removing trees that would provide shading and LWD and fully exposing the stream (USFS 1998j).

Squilchuck Creek. In Segment 11 there are few trees in the riparian zone of minimum length (>35 feet) to be classified as LWD. Much of the riparian conifers were removed many years ago (USFS 1998j).

### Pool Frequency

No information available.

### Pool Depth

No information available.

### Off-Channel Habitat

No information available.

## Water Quality

### Temperature

Squilchuck Creek. Stream temperatures taken in Squilchuck Creek have almost entirely been taken during the snow-making season. Temperatures have been recorded which range from 32 – 39°F during the winter (USFS 1998j). The only recorded water temperatures were taken during electroshocking of August 1991. Temperatures reported were: 42°F at 1300 hrs. adjacent to the Mission Ski Area parking lot and 45°F at 1430 hrs; 42°F at the confluence of Lake Creek (USFS 1998j). The NMFS rating criteria for instream temperature (NMFS 1996) identify temperatures between 50 –57°F as properly functioning condition for salmon and steelhead. No instream water temperature data has been collected in association with stream reaches affected by irrigation diversions or return flow. There is presently not enough data to determine if how instream temperatures have been modified by human influences in the drainage.

#### Fine Sediment

No information available.

#### Water Quantity

#### Dewatering

Watershed-wide. About 65% of the total annual water production occurs as snowmelt streamflow in April through July. Annually, there is an excess of available surface water during melt seasons (USFS 1998j) but inadequate supplies during the remaining portion of the year. This seasonal distribution of water supply has resulted in construction of water storage facilities by agricultural users. Squilchuck Creek was adjudicated in 1927 with no provisions for maintaining instream flows; certified water rights appear to exceed available surface flow on an annual basis (J. Monahan, DOE, pers. comm., 2001). Competition for water increases in late summer and early fall. Under natural conditions, channels in the lower portion of the Squilchuck watershed are dominated by naturally intermittent drainages that only flow during spring runoff or during high intensity summer thundershowers (USFS 1998j).

Squilchuck Creek. The channel has been modified by grading of the Tumwater ski run. The stream crosses the ski run as a shallow ditch and flows into a depression (2200 feet) and slight impoundment (2200-2300 feet). A perennial flow drains for the depression into a shallow ditch line alongside the road and disappears into rock talus. Surface flows re-emerge one-half mile down slope and 600 feet lower in elevation. From Topographical maps and other evidence, it was probably assumed the stream would flow to the right of Chair 2 instead of flowing to the left across the ski run and into the shallow depression at the end of the segment. At the time of the inspection, it appeared flow across the ski run was significantly less than in upper portions of the segment. Some portion of the flow may penetrate the talus slope with a very minimal flow crossing the ski run through dense perennial vegetation and into the well timbered, protected

depression. The Rubbleland-Rock type, where the stream disappears, has no potential to convey overland flow. (USFS 1998j).

Squilchuck Creek. Above the Tumwater ski run where the channel has been modified by grading activity, portions of the flow are subsurface, under angular rock. (USFS 1998j).

### Change in Flow Regime

Watershed-wide. Tree cover has been significantly reduced in the upper portion of the drainage from natural conditions (USFS 1998j). The once forested area of Squilchuck Creek is now either ski runs, chair lifts, or the maintenance road (USFS 1998j). Chair lifts and ski runs are completely revegetated with either introduced or native species and, in many cases, have a cover of young tree seedlings. Very little exposed mineral soil exists and that which does will revegetate rapidly (new regrading of the Mimi ski run). Current use of the ski area has insignificant potential effects on sediment transport or changes in basic hydrology. Probably the most significant influence, if measurable, would be delayed melt from increased snow accumulations on north facing ski runs, particularly from Chair 3 (USFS 1998j).

Squilchuck Creek. Water storage, reservoir management and water diversions have affected the natural flow regime of Squilchuck Creek (B. Steele, WDFW, pers. comm. 2001).

Squilchuck Creek. Release of irrigation water from the Beehive Reservoir augments streamflow between the reservoir outfall and points of diversion for individual water right holders. The effects of the diversions and return flows on instream habitat conditions are undetermined at this time. It is anticipated that this data gap will be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001).

### *Squilchuck Creek Watershed Fish Use and Distribution*

Historically, only the very lowest reaches of Squilchuck Creek would ever have been accessible to chinook salmon. Squilchuck Creek very quickly becomes a boulder/cobble dominated streambed with high gradient runs impassable to spring chinook. Steelhead/rainbow trout would have been distributed throughout the watershed where habitat was accessible, given the limited natural hydrology, as they are today. It is presumed anadromy extends into the headwaters (B. Steele, WDFW, pers. comm. 2000). There is no information available regarding historic bull trout use in the watershed although it is unlikely this species ever occurred in the watershed given the natural hydrology. Bull trout are not known to occur in the watershed currently.

Currently, spring chinook and steelhead distribution is limited to the lower 0.3 miles of Squilchuck Creek where the concrete apron on the S. Wenatchee Avenue bridge crossing

creates an impassable barrier to upstream fish migration. Rainbow trout and brook trout are distributed throughout the watershed where low flows, natural barriers and human-made fish passage barriers do not preclude access to habitat. Table 10 below, describes current, known salmon, steelhead and bull trout use in the Squilchuck Creek watershed. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 10: Current, known salmon, steelhead, and bull trout use in the Squilchuck Creek watershed.**

Squilchuck Creek Watershed	Spring Chinook			Summer Chinook			Steelhead/Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Squilchuck Creek		X					X	X							

*Squilchuck Creek Watershed Summary*

The extent to which this watershed can support salmon and steelhead/rainbow trout is most strongly limited by the natural hydrology and geology in this low precipitation watershed. Because of the reliance on snow accumulation and snowmelt to support instream flows in the watershed and the high permeability of the soils, access to habitat is very limited. This condition is worsened during low water years. Surface water diversions contribute to dewatering and low flows in Squilchuck although the extent to which they contribute to dewatering (or contribute to maintaining flows through irrigation water returns during the late summer), is unknown. Given the natural geology of the watershed, chinook salmon use is naturally limited to the lower reaches of Squilchuck Creek before steep channel gradient precludes upstream fish passage. Adult steelhead trout, being stronger swimmers and entering the drainage during spring runoff, could naturally penetrate higher into the watershed on good water years, given passage at culverts and diversion dams. However, intermittent flows later in the year, coupled with severe habitat degradation present significant limitations to steelhead/rainbow productivity in this watershed.

Providing fish passage at the S. Wenatchee Avenue culvert could benefit the Squilchuck Creek watershed steelhead/rainbow trout population by reestablishing connectivity with the Columbia basin populations. However, the extent of that benefit is limited by the quantity and quality of available habitat in the Squilchuck watershed. It is unknown how much habitat is available to steelhead/rainbow trout in the Squilchuck watershed, given the many fish passage barriers created by dewatering and low flows conditions and given the natural hydro-geologic conditions. Human-made fish passage barriers created at culverts exacerbate the naturally limiting conditions in the watershed.

### *Squilchuck Creek Watershed Data Gaps*

- The extent water diversions affect instream flows in anadromous-bearing waters.
- Redband trout distribution.

### *Squilchuck Creek Watershed Project Recommendations*

- Conduct redband trout distribution surveys.

## STEMILT CREEK WATERSHED

### *Stemilt Creek Watershed Description*

The Stemilt watershed is approximately 40 square miles in size with the headwaters of Stemilt Creek originating in the upper reaches of Naneum Ridge and Wenatchee Mountain. Stemilt Creek flows in a northeasterly direction from its headwaters for approximately 12.35 (Williams et al. 1975) miles before entering the Columbia River (RM 461.9) six and one half miles downstream of the Wenatchee River confluence (RM 468.4). Elevation ranges from 6600 along Naneum Ridge to 650 feet at the mouth. with the first 5 miles of stream flowing through private land ownership. Stemilt Creek County Road parallels the stream channel for the first 6 miles.

As in the Squilchuck watershed located north of and adjacent to the Stemilt, average annual precipitation is about 28 inches in the headwaters (6000-foot elevation) with precipitation rapidly decreasing with declining elevation. The 4000-foot elevation averages about 25 inches, with the 3000-foot elevation averaging about 20 inches annually (USFS 1998j). Precipitation occurs predominantly as snow from October to February. Runoff comes predominantly from melting of accumulated snow and occurs as snowmelt streamflow in April through July (USFS 1998j). Elevations below 3000 feet produce water but amounts are less significant due to aspect, vegetation, and rain shadow affect. Areas of the watershed below the elevation of 1500 feet do not produce streamflow except during rain, snow or thunderstorm events (USFS 1998j), however some springs have been identified in the lower reaches of Stemilt Creek (L. Riegert, Hammond, Collier, Wade, Livingstone Associates, pers. comm., 2001). Because of this seasonal distribution of water supply, agricultural users have constructed water storage facilities to store water during runoff periods so it can be delivered to agricultural users during periods of low flow (summer) .

### *Stemilt Creek Watershed Discussion of Hydrogeomorphology and Habitat Conditions*

Only one source of published information describing habitat conditions or land use affects on aquatic habitat in the Stemilt Creek watershed was found, the draft Chelan County Fish Barrier Inventory Database (Harza 2000). The Harza survey identified the first fish passage barrier culvert on Stemilt Creek at RM 1.6 on a private road crossing.

Regarding water use in the watershed, currently Hammond, Collier & Wade, Livingstone Associates of Wenatchee, Washington, has been hired to develop a Comprehensive Water Conservation Plan for the Stemilt Irrigation District. The plan is to analyze the District's irrigation distribution system and propose measures to conserve irrigation water within the District's facilities. The report is due out in late 2001. There are four irrigation districts operating within the Stemilt watershed; Wenatchee Heights Irrigation District, Stemilt Irrigation District, the Lower Stemilt Irrigation District, and the Kennedy-Lockwood Irrigation District. There are also numerous private diversions operating in the Stemilt watershed. Information on location and actual water use of surface waters in the watershed is not available at this time. The Stemilt watershed was adjudicated in 1926 with no provisions for maintaining instream flows; certified water rights appear to exceed available surface flow on an annual basis. Existing conditions reduce the flow in the lower two to three miles of Stemilt Creek to a trickle each year (L. Riegert, Hammond, Collier & Wade-Livingstone Associates, pers. comm., 2001). The flow in the lower portion of the creek during the irrigation season is a factor of the amount of available moisture resulting from snowmelt and precipitation – the more dry the year, the earlier Stemilt Creek will be reduced to a trickle. In every year, the more junior water right holders' water use is curtailed as instream flows decrease. Eventually, before the end of the irrigation season, even senior water right holders' water use may be reduced as flows continue to decrease (L. Riegert, Hammond, Collier & Wade, Livingstone Associates, pers. comm., 2001). Intermittent flows in the upper reaches of Stemilt Creek and its tributaries likely occurs naturally, given the hydrology and geology as it affects the interaction between ground and surface waters. It is possible that dewatering in lower Stemilt may also have occurred naturally on some, if not all years prior to Euro-American influence. The hydrology of the Stemilt watershed is not well known.

### *Stemilt Creek Watershed Current Known Habitat Conditions*

The following listed information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

### *Access to Spawning and Rearing*

#### Obstructions

(natural barriers are also provided here)

Stemilt Creek (40.0808). At RM 6.5, a culvert on Stemilt Hill Road is a barrier to fish passage (Harza 2000).

## Screens and Diversions

Stemilt Creek (40.0808). There are 4 irrigation districts diverting water from Stemilt Creek; Wenatchee Heights Irrigation District, Stemilt Irrigation District, Lower Stemilt Irrigation District, and Kennedy-Lockwood Irrigation District. There are also numerous private diversions diverting water within the watershed. There is currently no readily available information regarding location, actual water use, and screen condition for these diversion, however, the Stemilt Irrigation District is in the process of having prepared a Comprehensive Water Conservation Plan due for completion in late 2001.

### Riparian Condition

No information available.

### Channel Conditions/Dynamics

#### Streambank Condition

No information available.

#### Floodplain Connectivity

No information available.

#### Width/Depth Ratio

No information available.

### Habitat Elements

#### Channel Substrate

No information available.

#### Large Woody Debris

Stemilt Creek. Large woody debris recruitment in the lower one mile is poor (B. Steele, WDFW, pers. comm., 2001).

### Pool Frequency

No information available.

### Pool Depth

No information available.

### Off-Channel Habitat

No information available.

### Water Quality

#### Temperature

No information available.

#### Fine Sediment

No information available.

### Water Quantity

#### Dewatering

Stemilt Creek (40.0808). The Stemilt watershed was adjudicated in 1926 with no provisions for maintaining instream flows; certified water rights appear to exceed available surface flow on an annual basis (J. Monahan, DOE, pers. comm., 2001).

### Change in Flow Regime

Stemilt Creek. There are 4 irrigation districts diverting water from Stemilt Creek; Wenatchee Heights Irrigation District, Stemilt Irrigation District, Lower Stemilt Irrigation District, and the Kennedy-Lockwood Irrigation District. There are also numerous private diversions diverting water within the watershed. The effects of the diversions and return flows on instream habitat conditions are undetermined at this time. Uncertainties are anticipated to be addressed in the Wenatchee WRIA 45 Watershed Planning Act process (ESHB 2514) currently underway under the leadership of the Chelan County Watershed Program (TAC 2001). Also, the Stemilt Irrigation District is in the process of having prepared a Comprehensive Water Conservation Plan due for completion in late 2001.

Stemilt Creek. Water storage, reservoir management and water diversions have affected the natural flow regime of Stemilt Creek (B. Steele, WDFW, pers. comm. 2001).

*Stemilt Creek Watershed Fish Use and Distribution*

Historically, only the very lowest reaches of Stemilt Creek would ever have been accessible to chinook salmon. Stemilt Creek very quickly becomes a boulder/cobble dominated streambed with high gradient runs impassable to spring chinook. Steelhead/rainbow trout would have been distributed throughout the watershed where habitat was accessible, given the limited natural hydrology, as they are today. It is presumed anadromy extends into the headwaters (B. Steele, WDFW, pers. comm. 2000). There is no information available regarding historic bull trout use in the watershed although it is unlikely this species ever occurred in the watershed given the natural hydrology. Bull trout are not known to occur in the watershed currently.

Currently, electroshocking efforts up to about RM 1.0, have identified spring chinook and rainbow/steelhead juveniles from the mouth upstream to about RM 1.0 (B. Steele, WDFW, pers. comm., 2001). Rainbow trout and brook trout are distributed throughout the watershed where low flows, natural barriers and human-made fish passage barriers do not preclude access to habitat. Table 11 below, describes current, known salmon, steelhead, and bull trout use in the Stemilt Creek watershed. There is no additional information available. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 11: Current, known salmon, steelhead, and bull trout use in the Stemilt Creek watershed**

Stemilt Creek Watershed	Spring Chinook			Summer Chinook			Steelhead/Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Stemilt Creek		X					X	X							

*Stemilt Creek Watershed Summary*

The extent to which this watershed can support salmon and steelhead/rainbow trout is most strongly limited by the natural hydrology and geology in this low precipitation watershed. Because of the reliance on snow accumulation and snowmelt to support instream flows in the watershed and the high permeability of the soils, perennial flows are not supported in many areas of the watershed limiting access to habitat. This

condition is worsened throughout the watershed during low water years, and every year in the lower 3 to 6 miles of Stemilt Creek by water diversions which dewater the channel.

#### *Stemilt Creek Watershed Data Gaps*

- The extent water diversions affect instream flows in anadromous-bearing waters.
- Redband trout distribution.

#### *Stemilt Creek Watershed Project Recommendations*

- Conduct redband trout distribution surveys.

### COLOCKUM CREEK WATERSHED

#### *Colockum Creek Watershed Description*

The headwaters of Colockum Creek lie in the upper reaches of southernmost extent of Naneum Ridge. Colockum Creek flows in an easterly direction from its headwaters for approximately 12 miles before entering the Columbia River (RM 450.0) fifteen miles downstream of the Wenatchee River confluence. Elevation ranges from 5600 along Naneum Ridge to 650 feet at the mouth. The first 7.5 miles of stream flows through private land ownership and the remainder of the watershed mostly is in private land ownership. Colockum Road parallels the stream channel for the first 6 miles.

As in the Squilchuck and Stemilt watersheds located north of the Colockum, average annual precipitation is relatively low with precipitation rapidly decreasing with declining elevation. Precipitation occurs predominantly as snow and runoff comes predominantly from melting of accumulated snow from April through July. Perennial stream channels would be limited in this watershed and intermittent flows common.

#### *Colockum Creek Watershed Discussion of Hydrogeomorphology and Habitat Conditions*

There is no published information available on habitat conditions or land use affects on aquatic habitat in the Colockum Creek watershed. There were no culvert fish passage barriers identified in the Harza (2000) fish passage barrier inventory, however irrigation diversion structures in the drainage may hinder or block fish passage at some flows (Bob Steele, WDFW, pers. comm., 2001). These structures have not been evaluated for fish passage concerns.

#### *Colockum Creek Watershed Current Known Habitat Conditions*

The following listed information was compiled from a combination of existing data from published and unpublished sources, as well as the professional knowledge of members of

the Wenatchee 2496 TAC. The information presented in the report shows where field biologists have been and what they have seen or studied. It represent the known and documented locations of impacts. The absence of information for a stream does not necessarily imply that the stream is in good health but my instead indicate a lack of available information. All references to River Miles (RM) are approximate.

*Access to Spawning and Rearing*

Obstructions

(natural barriers are also provided here)

No known fish passage barriers identified in the drainage.

Screens and Diversions

Colockum Creek (40.0760). An irrigation diversion structure located approximately 1.0 miles up Colockum Creek may block fish passage at low flows (B. Steele, WDFW, pers. comm., 2001).

*Riparian Condition*

No information available.

*Channel Conditions/Dynamics*

Streambank Condition

No information available.

Floodplain Connectivity

No information available.

Width/Depth Ratio

No information available.

Habitat Elements

Channel Substrate

No information available.

Large Woody Debris

No information available.

Pool Frequency

No information available.

Pool Depth

No information available.

Off-Channel Habitat

No information available.

Water Quality

Temperature

No information available.

Fine Sediment

No information available.

Water Quantity

Dewatering

Colockum Creek (40.0760). Colockum Creek was adjudicated in 1913 with no provisions for maintaining instream flows; certified water rights appear to exceed available surface flow on an annual basis (J. Monahan, DOE, pers. comm., 2001).

Change in Flow Regime

No information available.

*Colockum Creek Watershed Fish Use and Distribution*

Historically, only steelhead/rainbow trout would have used the Colockum drainage. Steelhead/rainbow trout would have been distributed throughout the watershed where habitat was accessible, given the limited natural hydrology, as they are today. It is presumed anadromy extends into the headwaters (B. Steele, WDFW, pers. comm. 2000). There is no information available regarding historic bull trout use in the watershed although it is unlikely this species ever occurred in the watershed given the natural hydrology. Bull trout are not known to occur in the watershed currently.

Currently, rainbow/steelhead trout are known to occur, based on electro-fishing results, from the mouth upstream to Kingbury Canyon (RM 3.8; Steele, WDFW, pers. comm. 2001). Rainbow trout are distributed throughout the watershed where low flows, natural barriers and human-made fish passage barriers do not preclude access to habitat. Table 12 below, describes current, known salmon, steelhead, and bull trout use in the Colockum Creek watershed. There is no additional information available. Maps in Appendix A illustrate salmon, steelhead and bull trout distribution; tables in Appendix B provide supporting information for the fish distribution maps.

**Table 12: Current, known salmon, steelhead, and bull trout use in the Colockum Creek watershed.**

Colockum Creek Watershed	Spring Chinook			Summer Chinook			Steelhead/ Rainbow			Sockeye			Bull Trout		
	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration	Spawning	Rearing	Migration
Colockum Creek								X							

*Colockum Creek Watershed Summary*

The extent to which this watershed can support salmon and steelhead/rainbow trout is most strongly limited by the natural hydrology and geology in this low precipitation watershed. Because of the reliance on snow accumulation and snowmelt to support instream flows in the watershed and the high permeability of the soils, perennial flows are not supported in many areas of the watershed limiting access to habitat.

### *Colockum Creek Watershed Data Gaps*

- Redband trout surveys.

### *Colockum Creek Watershed Project Recommendations*

- Conduct redband trout surveys to determine distribution.

### **Wenatchee Subbasin Summary of Habitat Conditions: (WRIA 45, and including the Squilchuck, Stemilt, and Colockum portions of WRIA 40).**

To sustain salmonid populations in the Wenatchee subbasin, the present level of habitat functionality and connectivity among the watersheds in the upper Wenatchee subbasin must be maintained. This refers to the Little Wenatchee/White River, Nason Creek, and Chiwawa River watersheds which support important core populations of anadromous salmonids and bull trout. Among these watersheds, maintaining functioning floodplain habitat on the lower White River from the mouth upstream to the Panther Creek confluence at RM 13.1 is of primary importance. The majority of floodplain habitat on the lower White River, from the mouth upstream to the Napeequa River confluence (RM 11.0) is privately owned and therefore subject to the potential conversion from unconfined, functioning floodplain habitat within the channel migration zone, to an alternate land use. There is limited immediate need for habitat protection on the lower Little Wenatchee River where the floodplain is within USFS ownership and there is no evidence of loss of floodplain connectivity (USFS 1998c). Next, protecting functioning floodplain habitat in the Chiwawa River watershed in the Chikamin Flats area (RM 13.7) where Chikamin Creek flows into the lower Chiwawa River is necessary. Following protection of Chikamin Flats, there is a need to restore floodplain habitat in the lower Chiwawa River primarily from the mouth upstream to the Deep Creek confluence (RM 4.0). In the Nason Creek watershed, there is a need to protect the remaining functioning floodplain and riparian habitat, especially riparian habitat with mature riparian vegetation for LWD recruitment. In addition, restoring riparian habitat and floodplain functions in the lower 15.4 miles of Nason Creek is necessary to insure the sustainability of salmonid populations in this watershed. Reducing human-induced sediment input watershed-wide from past timber harvests and road impacts is also important.

To provide for the year-round spawning, rearing and migratory habitat needs of all life history stages of spring and summer chinook salmon, steelhead trout, sockeye salmon and bull trout, floodplain habitat along the Wenatchee River corridor must be managed to provide adequate quantities of naturally-forming, accessible, high quality, watered, off-channel habitat. This includes the lower reaches of tributaries to the Wenatchee River which are within the channel migration zone of the Wenatchee. Given that the level of functionality and connectivity of the upper watersheds is maintained, habitat conditions in the mainstem Wenatchee River (RM 0.0 – 54.2) have the greatest potential to affect salmonid fish production in the Wenatchee subbasin. Spring chinook and steelhead spawn, rear and overwintering in the mainstem Wenatchee River; all summer chinook

spawning and rearing in the subbasin occurs in the mainstem of the Wenatchee River. The mainstem of the Wenatchee River serves as the corridor through which chinook, steelhead, sockeye and fluvial bull trout must pass to access habitat within the subbasin. It also allows for maintaining connectivity among the watersheds in the Wenatchee subbasin as well as with the greater Columbia River system. Habitat in the Wenatchee River corridor is necessary to provide refuge from high velocity flows and predation, and to provide overwintering habitat. Protecting existing side channel habitat and functioning floodplains where habitat-forming processes can naturally create and maintain side channel habitat is the most effective means to achieve this goal. Where side channel and floodplain habitat has been disconnected by the placement of berms, removal of the berms then allowing for passive restoration is an option. This is a very effective means for restoring side channel or floodplain habitat. Active side channel reconstruction and rehabilitation may also be an option in limited circumstances but may be more costly to achieve and maintain.

Reestablishing fish passage at human-made barriers on Icicle Creek, while protecting existing functioning floodplain and riparian habitat would provide access to a Wenatchee subbasin watershed that is relatively unimpacted by human land-use activities and is the largest tributary drainage by area to the Wenatchee River. This is dependent on fish passage through the boulder field at RM 5.6, which may vary by species and with instream conditions. Reconnecting the Icicle Creek watershed to the rest of the Wenatchee subbasin has the potential to contribute to: 1) maintaining bull trout populations and restoring the fluvial bull trout life history form to the Icicle Creek watershed; 2) reestablishing a strong, wild steelhead run in the Icicle Creek watershed; and 3) opening additional spawning and rearing habitat to spring chinook in the Wenatchee subbasin. To fully realize the potential benefits of reestablishing connectivity between the majority of the Icicle Creek watershed and the rest of the Wenatchee subbasin, low instream flows and high instream temperatures must also be addressed in Icicle Creek from the mouth upstream to RM 5.7. Habitat restoration projects aimed at restoring the channel's ability to dissipate energy and manage sediment loads would further improve salmonid productivity in the watershed. This includes restoring floodplain function, riparian function, and channel-forming processes below the USFS wilderness boundary at RM 17.5. and reducing human-induced sediment input.

The watersheds and drainages located in the lower Wenatchee subbasin (Chumstick Creek drainage, Mission Creek watershed, and Peshastin Creek watershed) have been severely altered from their naturally functioning condition and are highly fragmented. Salmon, steelhead and bull trout populations in these watersheds are significantly reduced from their historic potential and, due to the existing land use activities and management issues, the Chumstick, Mission, and Peshastin watersheds have less potential for recovery than watersheds in the upper Wenatchee subbasin. However, it should be noted that based on one year of data from a Douglas County PUD telemetry study, significant numbers of steelhead were determined to be spawning in lower Peshastin Creek. The relative contributions to flows in the Wenatchee River are 0.2%, 2% and 4%, respectively, from these drier watersheds of the subbasin, while out-of-stream water use for agricultural and domestic development is high relative to available flows. Dewatering

immediately downstream of irrigation diversions occurs on both Peshastin and Mission creeks, with low flows of 2 cfs occurring in lower Chumstick Creek where there are many private diversions and wells affecting surface flows to an undetermined extent.

Among these watersheds, restoring stream sinuosity and floodplain function to Peshastin Creek is of primary importance given the watershed's potential to contribute to bull trout, spring chinook and steelhead production in the Wenatchee subbasin. Restoration of floodplain function and off-channel habitats and wetlands in Peshastin Creek would also contribute to improving low instream flow conditions in Peshastin Creek. Second to restoring channel functions, instream flow improvements must be addressed to fully realize Peshastin Creek watershed's potential contribution to salmonid production in the Wenatchee subbasin. Other types of habitat restoration projects should be delayed until stream sinuosity and low flows in the Peshastin Creek watershed can be addressed. In the Mission Creek watershed, prior to undertaking instream habitat restoration and fish passage improvement projects, low instream flow problems as exacerbated by human land use must be addressed. Thereafter, restoring unconfined channel migration, reducing human-induced sediment input, and reestablishing fish passage should be addressed. In the Chumstick Creek watershed, restoring fish passage is of primary concern. Second, protecting functioning floodplain and riparian habitat is critical. Restoring floodplain function and riparian habitat and reducing sediment delivery to stream channels in the watershed is also critical to improving salmonid production in the watershed. Improving instream flows through any available means also needs to be pursued.

The Squilchuck, Stemilt and Colockum drainages of WRIA 40 are extremely low surface water producers given their arid climate and geologic condition. Fish production in these drainages are strongly affected by low water years when available moisture is limited to a brief spring runoff event with which to sustain instream flows in most reaches. With the development of water reservoirs in these watersheds for irrigated agriculture, during some years instream flows may be sustained during the summer months by irrigation return flows. In these drainages, only the lower reaches of Squilchuck, Stemilt and Colockum creeks have any potential to support anadromous salmonids, with the upper extent naturally limited by gradient and/or stream channel size and flows. These drainages are primarily or exclusively steelhead/rainbow trout waters with chinook use, when not precluded by flows, limited to "pull-in" rearing by summer chinook and spring chinook juveniles migrating through the Columbia River system. The potential for contributing to anadromous salmonid production in the Upper Columbia River region is extremely limited given the naturally limiting conditions in these drainages and the land use impacts in the floodplains and channel migration zones of the mainstem creeks. However, of interest is the distribution and status of native redband trout populations in these watersheds, which may contribute to steelhead populations in high water years. Redband trout surveys are needed to establish distribution.

## ASSESSMENT OF HABITAT LIMITING FACTORS

The 2496 Wenatchee TAC assessed habitat conditions by stream reach (Table 13) for those habitat factors identified and described in the chapter of this report titled, “Salmonid Habitat Conditions”. The assessment only includes streams where salmon, rainbow/steelhead, or bull trout are known to occur, or where habitat conditions in the stream have the potential to contribute to degrading habitat conditions in known salmonid-bearing waters. Ratings of “Good”, “Fair” or “Poor” were assigned during the assessment using the Wenatchee Subbasin Habitat Rating Criteria outlined in Appendix E. The information upon which the assessment is based was derived from published sources and the combined professional knowledge of the TAC participants. Therefore, each rating incorporates how one or more biologist judged the quality of habitat for the various stream reaches based on available information. The number “1” assigned to the rating indicates quantitative studies or published reports exist to support the rating. The number “2” assigned to the rating indicates the professional knowledge of the TAC was used to rate the condition and data analysis, data, or published reports were not available. If a habitat attribute rated as “Fair” or “Poor” based on the Habitat Rating Criteria but the conditions was determined to be the result of naturally occurring ecosystem processes, the attribute was given a rating of “Good” in the assessment table. This gives the user a quick and realistic view from the table of which habitat attributes are properly functioning.

The assessment shows where field biologists have been and what they have seen or studied. Where “**DG**” (Data Gap) appears in the table, there was so little information available on the habitat condition (published or professional knowledge) that the TAC did not feel confident making even a qualitative determination of condition for the habitat factor. The absence of a stream on the list does not mean salmon, rainbow/steelhead or bull trout do not occur in the stream or imply that the stream is in good health. Some streams may not be listed because they have not been documented to support salmon, rainbow/steelhead, or bull trout nor been surveyed for stream health conditions. Others streams may show more impacts because they are easily accessible or have been the focus of more scientific study.

Habitat ratings provided in the assessment table can be correlated back to habitat conditions presented in the “Salmonid Habitat Conditions” chapter. For example, dewatering in the reach of Peshastin Creek from 0.0 – 9.0 is rated “**P1**” (“poor” based on qualitative studies or published reports). Turning to the Peshastin Creek watershed section of the “Salmonid Habitat Conditions” chapter, subheading, “Dewatering” (page 168) , the lower 2.4 miles of Peshastin Creek are identified as dewatering as a result of Peshastin Irrigation District water diversions.

**Table 13. Assessment of habitat conditions limiting salmonid performance**

**P** = Average habitat condition considered to be poor (Not Properly Functioning)

**F** = Average habitat condition considered to be fair (At Risk)

**G** = Average habitat condition considered to be good (Properly Functioning)

**1** = Quantitative studies, surveys, or published reports documenting habitat condition

**2** = Professional knowledge of the TAG members

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STREAM NAME	WRIA INDEX	Access to Spawning and Rearing		Riparian Condition	Channel Conditions/Dynamics				Habitat Elements					Water Quality		Water Quantity	
		Artificial Obstructions	Screens and diversions		Streambank Condition	Floodplain Connectivity	Width/Depth Ratio	Entrenchment Ratio	Channel Substrate	LWD	Pool Frequency	Pool Depth	Off-Channel Habitat	Temperature	Fine Sediment	Dewatering	Change in Flow Regime
<b>MAINSTEM WENATCHEE RIVER WATERSHED</b>																	
<b>Wenatchee River</b>	45.0700																
Lower Wenatchee River (RM 0.0-25.6)																	
RM 0.0 -10.4 (Mission Creek confluence)		<b>G1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>F2</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>F2</b>	<b>P1</b>	<b>F1</b>	<b>DG</b>	<b>G2</b>	<b>F1</b>
RM 10.5 - 23.9 (Leavenworth Hwy. 2 bridge)		<b>G1</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>F1</b>	<b>NA</b>	<b>F2</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>F2</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>F1</b>
RM 23.9 - RM 25.6 (Icicle Creek confluence)		<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>G2</b>	<b>G2</b>	<b>NA</b>	<b>F2</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>G2</b>	<b>G2</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>F1</b>
Middle Wenatchee River (RM 25.6-35.6)																	
RM 25.6 - 35.6/ 2nd Hwy 2 bridge at top of Tumwater Cyn		<b>G1</b>	<b>DG</b>	<b>F2</b>	<b>F1</b>	<b>G2</b>	<b>NA</b>	<b>F1</b>	<b>DG</b>	<b>F1</b>	<b>F1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
Upper Wenatchee River (35.6 - 54.2)																	
RM 35.6 - 54.2 (Lake Wenatchee)		<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>G1</b>	<b>F1</b>	<b>NA</b>	<b>F1</b>	<b>DG</b>	<b>F2</b>	<b>F2</b>	<b>G2</b>	<b>F1</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
<b>Derby Canyon Drainage</b>																	
<b>Derby Canyon Creek (RM 19.0)</b>	45.0386																
RM 0.0 - 3.0/NB		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P2</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P2</b>	<b>P1</b>

**Table 13. Assessment of habitat conditions limiting salmonid performance**

**P** = Average habitat condition considered to be poor (Not Properly Functioning)

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STREAM NAME	WRIA INDEX	Access to Spawning and Rearing		Riparian Condition	Channel Conditions/Dynamics				Habitat Elements					Water Quality		Water Quantity	
		Artificial Obstructions	Screens and diversions		Streambank Condition	Floodplain Connectivity	Width/Depth Ratio	Entrenchment Ratio	Channel Substrate	LWD	Pool Frequency	Pool Depth	Off-Channel Habitat	Temperature	Fine Sediment	Dewatering	Change in Flow Regime
<b>MAINSTEM WENATCHEE RIVER WATERSHED</b>																	
<b>Wenatchee River</b>	45.0700																
Lower Wenatchee River (RM 0.0-25.6)																	
RM 0.0 -10.4 (Mission Creek confluence)		<b>G1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>F2</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>F2</b>	<b>P1</b>	<b>F1</b>	<b>DG</b>	<b>G2</b>	<b>F1</b>
RM 10.5 - 23.9 (Leavenworth Hwy. 2 bridge)		<b>G1</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>F1</b>	<b>NA</b>	<b>F2</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>F2</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>F1</b>
RM 23.9 - RM 25.6 (Icicle Creek confluence)		<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>G2</b>	<b>G2</b>	<b>NA</b>	<b>F2</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>G2</b>	<b>G2</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>F1</b>
Middle Wenatchee River (RM 25.6-35.6)																	
RM 25.6 - 35.6/ 2nd Hwy 2 bridge at top of Tumwater Cyn		<b>G1</b>	<b>DG</b>	<b>F2</b>	<b>F1</b>	<b>G2</b>	<b>NA</b>	<b>F1</b>	<b>DG</b>	<b>F1</b>	<b>F1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
Upper Wenatchee River (35.6 - 54.2)																	
RM 35.6 - 54.2 (Lake Wenatchee)		<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>G1</b>	<b>F1</b>	<b>NA</b>	<b>F1</b>	<b>DG</b>	<b>F2</b>	<b>F2</b>	<b>G2</b>	<b>F1</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
<b>Derby Canyon Drainage</b>																	
<b>Derby Canyon Creek (RM 19.0)</b>	45.0386																
RM 0.0 - 3.0/NB		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P2</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P2</b>	<b>P1</b>

**Table 13. Assessment of habitat conditions limiting salmonid performance**

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STREAM NAME	WRIA INDEX	Access to Spawning and Rearing		Riparian Condition	Channel Conditions/Dynamics				Habitat Elements					Water Quality		Water Quantity	
		Artificial Obstructions	Screens and diversions		Streambank Condition	Floodplain Connectivity	Width/Depth Ratio	Entrenchment Ratio	Channel Substrate	LWD	Pool Frequency	Pool Depth	Off-Channel Habitat	Temperature	Fine Sediment	Dewatering	Change in Flow Regime
<b>Chumstick Creek Drainage</b>																	
<b>Chumstick Creek (RM 23.5)</b>	45.0402																
RM 0.0 - 5.1 (confl. of Sunitsch Crk.)		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>P1</b>	<b>G1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>
<b>Eagle Creek (RM 1.9)</b>	45.0404																
RM 0.0 - 1.1		<b>G1</b>	<b>DG</b>	<b>P2</b>	<b>P2</b>	<b>P2</b>	<b>DG</b>	<b>DG</b>	<b>P2</b>	<b>P2</b>	<b>P2</b>	<b>P2</b>	<b>P2</b>	<b>P2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>
<b>Chiwaukum Creek Drainage</b>																	
<b>Chiwaukum Creek (RM 36.0)</b>	45.0700																
RM 0.0 - 0.6		<b>F1</b>	<b>DG</b>	<b>F1</b>	<b>F1</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>DG</b>	<b>P2</b>	<b>P1</b>	<b>P1</b>	<b>G1</b>	<b>DG</b>	<b>F2</b>	<b>G1</b>	<b>G2</b>
RM 0.6 - RM 2.1		<b>DG</b>	<b>P2</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>DG</b>	<b>F2</b>	<b>G1</b>	<b>G2</b>
<b>Skinney Creek (0.6)</b>	45.0701																
RM 0.0 - 0.5		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>F1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>F2</b>	<b>P2</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>G2</b>	<b>DG</b>
<b>Beaver Creek Drainage</b>																	
<b>Beaver Creek (RM 46.5)</b>	45.0751																
RM 0.0 - 3.1		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>F2</b>	<b>F1</b>	<b>DG</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>G2</b>	<b>F1</b>

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STREAM NAME	WRIA INDEX	Access to Spawning and Rearing		Riparian Condition	Channel Conditions/Dynamics				Habitat Elements					Water Quality		Water Quantity	
		Artificial Obstructions	Screens and diversions		Streambank Condition	Floodplain Connectivity	Width/Depth Ratio	Entrenchment Ratio	Channel Substrate	LWD	Pool Frequency	Pool Depth	Off-Channel Habitat	Temperature	Fine Sediment	Dewatering	Change in Flow Regime
<b>MISSION CREEK WATERSHED</b>																	
<b>Mission Creek (RM 10.4)</b>	45.0089																
RM 0.0 - 6.9		<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>F1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>
RM 6.9 - 10.3 (Devil's Gulch)		<b>DG</b>	<b>DG</b>	<b>F1</b>	<b>DG</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P2</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>G2</b>	<b>DG</b>
RM 10.3 - RM 15.7		<b>DG</b>	<b>DG</b>	<b>F1</b>	<b>DG</b>	<b>NA</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>NA</b>	<b>DG</b>	<b>P1</b>	<b>G2</b>	<b>DG</b>
<b>Brender Creek (RM 0.2)</b>	45.0090																
RM 0.0 - 0.7		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P2</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>G1</b>	<b>P1</b>
RM 0.7 - 3.0 (USFS boundary)		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P2</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>G1</b>	<b>P1</b>
RM 3.0 - headwaters		<b>P1</b>	<b>DG</b>	<b>F2</b>	<b>DG</b>	<b>F2</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>P2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>
<b>Yaksum Creek (RM 1.9)</b>	45.0100																
RM 0.0 - 1.6 (upper extent of Harza 2000 survey)		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>
<b>Sand Creek (RM 7.5)</b>	45.0135																
RM 0.0 - 1.7 (Little Camas Creek conflu.)		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>F2</b>	<b>P1</b>	<b>NA</b>	<b>F1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>
RM 1.7 - RM 2.5 (about 1/2 mi. above Little Camas Crk confluence)		<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>F2</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>

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STREAM NAME	WRIA INDEX	Access to Spawning and Rearing		Riparian Condition	Channel Conditions/Dynamics				Habitat Elements					Water Quality		Water Quantity	
		Artificial Obstructions	Screens and diversions		Streambank Condition	Floodplain Connectivity	Width/Depth Ratio	Entrenchment Ratio	Channel Substrate	LWD	Pool Frequency	Pool Depth	Off-Channel Habitat	Temperature	Fine Sediment	Dewatering	Change in Flow Regime
<u>Little Camas Creek (RM 1.7)</u>	45.0140																
RM 0.0 - 1.8		<b>P1</b>	<b>DG</b>	<b>F1</b>	<b>DG</b>	<b>F2</b>	<b>NA</b>	<b>P2</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>
<u>E. Fk. Mission Creek (RM 10.2)</u>	45.0157																
RM 0.0 - 4.2 (about where E. Fk. Heads south)		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>F2</b>	<b>P1</b>	<b>NA</b>	<b>P2</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>
<b>PESHASTIN CREEK WATERSHED</b>																	
<u>Peshastin Creek (RM 17.9)</u>	45.0232																
RM 0.0 - RM 9.0		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P2</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>
RM 9.0 - 15.4		<b>G1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>G2</b>	<b>F2</b>
RM 15.4 - 17.5		<b>G2</b>	<b>DG</b>	<b>F1</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>NA</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>
<u>Mill Creek (RM 5.2)</u>	45.0245																
RM 0.0 - 2.3 (FS Rd. 7300 crossing)		<b>P2</b>	<b>DG</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>DG</b>	<b>P1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>G2</b>	<b>F1</b>
<u>Hansel Creek (RM 8.7)</u>	45.0265																
RM 0.0 - 0.9		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>NA</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>F1</b>	<b>NA</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>DG</b>

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<u>Ingalls Creek (RM 9.4)</u>	45.0273																
RM 0.0 - 9.8/NB		<b>G2</b>	<b>DG</b>	<b>G1</b>	<b>G1</b>	<b>DG</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>
<u>Ruby Creek (RM 10.5)</u>	45.0318																
RM 0.0 - 1.5		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>G1</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>F1</b>	<b>G1</b>	<b>P1</b>	<b>G2</b>	<b>G2</b>
<u>Negro Creek (RM 11.1)</u>	45.0323																
RM 0.0 - 2.9/NB		<b>G2</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>F1</b>	<b>NA</b>	<b>F1</b>	<b>F1</b>	<b>P1</b>	<b>F1</b>	<b>F1</b>	<b>F1</b>	<b>G1</b>	<b>F1</b>	<b>G2</b>	<b>G1</b>
<u>Tronsen Creek (RM 14.9)</u>	45.0346																
RM 0.0 - 5.9 (Hwy. 97 culvert barrier)		<b>P1</b>	<b>G1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>F1</b>	<b>F1</b>	<b>P1</b>	<b>F1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>G2</b>	<b>F2</b>
<u>Shaser Creek (RM 15.5)</u>	45.0347																
RM 0.0 - 1.3		<b>G2</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>F2</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>
<u>N. Fk. Shaser Creek (RM 0.4)</u>	45.0365																
RM 0.0 - 1.5		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>F2</b>	<b>P1</b>	<b>G2</b>	<b>DG</b>
<u>M. Fk. Shaser Creek (RM 1.3)</u>	45.0366																
RM 0.0 - 2.6		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>F2</b>	<b>P1</b>	<b>G2</b>	<b>DG</b>

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<b>Scotty Creek (RM 16.6)</b>	45.0376																
RM 0.0 - 1.9		<b>G2</b>	<b>DG</b>	<b>F1</b>	<b>P1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>DG</b>
<b>ICICLE CREEK WATERSHED</b>																	
<b>Icicle Creek (RM 25.6)</b>	45.0474																
RM 0.0 - 2.8 (LNFH diversion dam)		<b>G1</b>	<b>DG</b>	<b>P1</b>	<b>F1</b>	<b>P2</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>P1</b>	<b>F1</b>	<b>F1</b>	<b>P2</b>	<b>P1</b>	<b>F2</b>	<b>G1</b>	<b>P1</b>
RM 2.8 - 3.8 (historic channel)		<b>P1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>F1</b>	<b>P1</b>	<b>NA</b>	<b>P1</b>	<b>P2</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P1</b>	<b>P2</b>	<b>P1</b>	<b>P1</b>
RM 3.8 - 17.5 (wilderness boundary)		<b>F1</b>	<b>P1</b>	<b>F1</b>	<b>F1</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>F2</b>	<b>F1</b>	<b>F1</b>	<b>F1</b>	<b>G1</b>	<b>P1</b>	<b>F2</b>	<b>P2</b>	<b>F1</b>
RM 17.5 - 24.0/NB		<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>
<b>Eightmile Creek (RM 9.0)</b>	45.0506																
RM 0.0 - 0.5/NB		<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>F1</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>F2</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
<b>Jack Creek (RM 17.2)</b>	45.0543																
RM 0.0 - 0.87		<b>G1</b>	<b>G2</b>	<b>F1</b>	<b>G1</b>	<b>G2</b>	<b>NA</b>	<b>F2</b>	<b>DG</b>	<b>F1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
<b>French Creek (RM 21.6)</b>	45.0587																
RM 0.0 - 5.5 (confluence of Klonauqa Crk.)		<b>G1</b>	<b>G2</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>

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<b>CHIWAHA RIVER WATERSHED</b>																	
<b>Chiwawa River (RM 48.4)</b>	45.0759																
RM 0.0 - 13.7 (Chikamin Creek)		<b>G1</b>	<b>G1</b>	<b>F1</b>	<b>F1</b>	<b>G1</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>F2</b>	<b>F2</b>	<b>G1</b>	<b>G2</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
RM 13.7 - 30.2 (Phelps Creek)		<b>G1</b>	<b>G2</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G2</b>	<b>G2</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
RM 30.2 - 33.1/NB		<b>G1</b>	<b>G2</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G2</b>	<b>G2</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>
<b>Big Meadows Creek (RM 9.2)</b>	45.0776																
RM 0.0 - 0.5 (Rd. 6300)		<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>G1</b>	<b>DG</b>	<b>G1</b>	<b>G2</b>	<b>G2</b>
<b>Chikamin Creek (RM 13.7)</b>	45.0798																
RM 0.0 - 0.9 (Marble Creek)		<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>G1</b>	<b>F1</b>	<b>NA</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G2</b>	<b>G2</b>
RM 0.9 - 6.7 (Rd. 6210 culvert)		<b>P1</b>	<b>G2</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G2</b>	<b>G2</b>
<b>Rock Creek (RM 21.3)</b>	45.0842																
RM 0.0 - 1.0 (0.33 mile above Rd 6200 crossing)		<b>G1</b>	<b>G2</b>	<b>G1</b>	<b>F1</b>	<b>F1</b>	<b>F1</b>	<b>NA</b>	<b>DG</b>	<b>F1</b>	<b>F1</b>	<b>G1</b>	<b>G2</b>	<b>G1</b>	<b>DG</b>	<b>G2</b>	<b>G1</b>
RM 1.0 - RM 5.5 (logjam/bedrock chute)		<b>G1</b>	<b>G2</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>
<b>Phelps Creek (RM 30.7)</b>	45.0875																

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RM 0.0 - 1.0/NB		G1	G2	G1	G1	G1	G1	G1	G1	G1	G1	G2	G2	G1	G2	G1	G1
<b>James Creek (RM 31.2)</b>	45.0877																
RM 0.0 - 0.25/NB		G1	G2	G1	G1	G1	G1	G1	G1	G1	G1	G2	G2	G2	G2	G2	G2
<b>Alpine Creek (RM 31.7)</b>	45.0879																
RM 0.0 - 0.1		G1	DG	G1	G1	G1	G1	G1	G1	G1	G1	G2	G2	G2	G2	G2	G2
<b>Buck Creek (RM 33.0)</b>	45.0882																
RM 0.0 - 0.5		G1	G2	G1	G1	G1	G1	G1	G1	G1	G1	G2	G2	G2	G2	G2	G2
<b>NASON CREEK WATERSHED</b>																	
<b>Nason Creek (RM 53.6)</b>	45.0888																
RM 0.0 - 4.0 (Coles Corner)		G1	DG	P1	P1	P1	P1	NA	P2	P1	P1	P1	P1	P1	P1	G2	DG
RM 4.0 - 16.8/NB (Gaynor Falls)		G1	DG	P1	P1	P1	P1	NA	P2	P1	P1	P1	P1	DG	P1	G2	DG
RM 16.8 - 20.5 (Bygone Byways)		G1	DG	F1	F1	F1	F1	NA	F1	F1	F1	F1	P1	DG	DG	G2	DG
<b>Kahler Creek (RM 5.1)</b>	45 0890																
RM 0.0 - 1.9		G1	DG	P1	P1	G2	DG	DG	DG	P2	P2	DG	G1	DG	P1	G2	DG

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<u>Roaring Creek (RM 8.4)</u>	45.0894																
RM 0.0 - 1.1/NB		<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>F2</b>	<b>P1</b>	<b>F2</b>	<b>F2</b>	<b>G1</b>	<b>DG</b>	<b>P2</b>	<b>G2</b>	<b>DG</b>
<u>Coulter Creek (RM 0.1)</u>	45.0895																
RM 0.0 - 0.4		<b>P1</b>	<b>DG</b>	<b>P2</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>F2</b>	<b>P1</b>	<b>P1</b>	<b>F2</b>	<b>G1</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>DG</b>
<u>Gill Creek (RM 9.3)</u>	45.0902																
RM 0.0 - 0.22		<b>G1</b>	<b>DG</b>	<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>F2</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>G1</b>	<b>DG</b>	<b>F2</b>	<b>G1</b>	<b>DG</b>
<u>Whitepine Creek (RM 14.6)</u>	45.0918																
RM 0.0 - 0.5		<b>G1</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G1</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>
<u>Mill Creek (RM19.9)</u>	45.0956																
RM 0.0 - 0.6		<b>P1</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>F2</b>	<b>F1</b>	<b>G1</b>	<b>F1</b>	<b>G2</b>	<b>DG</b>	<b>F2</b>	<b>G1</b>	<b>G2</b>
<b>WHITE/LITTLE WENATCHEE RIVER WATERSHED</b>																	
<u>White River (RM 58.6)</u>	45.1116																
RM 0.0 - 6.4		<b>F2</b>	<b>DG</b>	<b>F1</b>	<b>G1</b>	<b>F1</b>	<b>G1</b>	<b>G1</b>	<b>DG</b>	<b>F1</b>	<b>F1</b>	<b>G1</b>	<b>F2</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G1</b>

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STREAM NAME	WRIA INDEX	Access to Spawning and Rearing		Riparian Condition	Channel Conditions/Dynamics				Habitat Elements					Water Quality		Water Quantity	
		Artificial Obstructions	Screens and diversions		Streambank Condition	Floodplain Connectivity	Width/Depth Ratio	Entrenchment Ratio	Channel Substrate	LWD	Pool Frequency	Pool Depth	Off-Channel Habitat	Temperature	Fine Sediment	Dewatering	Change in Flow Regime
RM 6.4 - 11.0 (Napeequa River)		G1	DG	F1	G1	F1	G1	G1	G1	F1	F1	G1	F2	G1	G1	G2	G1
RM 11.0 - 14.3/NB		G1	DG	G1	G1	F1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G2
<u>Sears Creek (7.7)</u>	45.1121																
RM 0.0 - 0.35 (Rd. 6404)		P1	DG	G2	G2	G2	G2	G2	DG	G2	G2	G2	G2	G2	DG	G2	G2
<u>Canyon Creek (RM 10.0)</u>		45.1128															
RM 0.0 - 0.2		G1	DG	G2	G2	G2	G2	G2	DG	G2	G2	G2	G2	G2	DG	G2	G2
<u>Napeequa River (11.0)</u>		45.1138															
RM 0.0 - 2.2/NB		G1	DG	G1	G1	G1	G2	G2	G1	F1	G1	G1	G1	G2	G1	G2	G1
<u>Panther Creek (RB 13.1)</u>		45.0717															
RM 0.0 - 0.7/NB		G1	G2	G1	G1	G1	G1	G1	G1	G1	G1	G1	G1	G2	G2	G2	G1
<b>Little Wenatchee River (RM 58.6)</b>		45.0985															
RM 0.0 - 1.5 (Two Rivers Sand & Gravel Pit)		G1	DG	F1	G1	G1	F2	NA	DG	G1	G1	G1	G1	DG	DG	G2	DG
RM 1.5 - RM 7.8/NB		G1	DG	F1	G1	G1	F2	NA	DG	G1	G1	G1	G1	DG	DG	G2	DG
RM 7.8 - 16.9		G1	DG	G1	G1	G1	G1	G1	F1	G1	G1	G1	G1	DG	DG	G2	DG

**Table 13. Assessment of habitat conditions limiting salmonid performance**

**P** = Average habitat condition considered to be poor (Not Properly Functioning)

**F** = Average habitat condition considered to be fair (At Risk)

**G** = Average habitat condition considered to be good (Properly Functioning)

**1** = Quantitative studies, surveys, or published reports documenting habitat condition

**2** = Professional knowledge of the TAG members

**NA** = Not Applicable.

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STREAM NAME	WRIA INDEX	Access to Spawning and Rearing		Riparian Condition	Channel Conditions/Dynamics				Habitat Elements					Water Quality		Water Quantity		
		Artificial Obstructions	Screens and diversions		Streambank Condition	Floodplain Connectivity	Width/Depth Ratio	Entrenchment Ratio	Channel Substrate	LWD	Pool Frequency	Pool Depth	Off-Channel Habitat	Temperature	Fine Sediment	Dewatering	Change in Flow Regime	
<b>Rainy Creek (RM 8.4)</b>	45.0998																	
RM 0.0 - 5.5/NB		<b>G1</b>	<b>DG</b>	<b>G1</b>	<b>G1</b>	<b>F1</b>	<b>NA</b>	<b>F1</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>	<b>G2</b>	<b>F1</b>	<b>DG</b>	<b>DG</b>	<b>G2</b>	<b>G2</b>	
<b>Lake Wenatchee (RM 54.2)</b>																		
RM 54.2/outlet - 58.6/inlet		<b>G2</b>	<b>DG</b>	<b>F2</b>	<b>F2</b>	<b>DG</b>	<b>NA</b>	<b>NA</b>	<b>DG</b>	<b>DG</b>	<b>NA</b>	<b>NA</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>NA</b>	<b>DG</b>	
<b>SQUILCHUCK CREEK WATERSHED (WRIA 40)</b>																		
<b>Squilchuck Creek (RM 464.0)</b>	40.0836																	
RM 0.0 - 0.3 (S. Wenatchee Ave.)		<b>P1</b>	<b>DG</b>	<b>F2</b>	<b>F2</b>	<b>P2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>F2</b>	
RM 0.3 - 1.9 (flume)		<b>P1</b>	<b>DG</b>	<b>F2</b>	<b>DG</b>	<b>F2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>F2</b>
RM 1.9 - headwaters		<b>P1</b>	<b>DG</b>	<b>F2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>F2</b>
<b>STEMILT CREEK WATERSHED (WRIA 40)</b>																		
<b>Stemilt Creek (RM 461.9)</b>	40.0808																	
RM 0.0 - 1.0		<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P2</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P2</b>	<b>F2</b>	
RM 1.0 - headwaters		<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P2</b>	<b>F2</b>	

**Table 13. Assessment of habitat conditions limiting salmonid performance**

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		Artificial Obstructions	Screens and diversions		Streambank Condition	Floodplain Connectivity	Width/Depth Ratio	Entrenchment Ratio	Channel Substrate	LWD	Pool Frequency	Pool Depth	Off-Channel Habitat	Temperature	Fine Sediment	Dewatering	Change in Flow Regime
<b>COLOCKUM CREEK WATERSHED (WRIA 40)</b>																	
<b>Colockum Creek (RM 450.0)</b>	40.0760																
RM 0.0 - headwaters		<b>P1</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>DG</b>	<b>P2</b>	<b>DG</b>

**NOTES:**

1. In the Wenatchee watershed, stream reaches above upper extents of known salmon, steelhead/rainbow or bull trout distribution are not considered to be contributing to the degradation of habitat conditions downstream if not addressed in the report (Wenatchee TAC 2000)
2. All River Miles are approximate.
3. Uppermost RM provided for a given stream represent the upper extent of known salmon, steelhead/rainbow or bull trout distribution.
4. Habitat ratings reflect the current condition of the habitat attribute relative to its geomorphological potential.

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## GLOSSARY

**303 (d) List:** The federal Clean Water Act requires states to maintain a list of stream segments that do not meet water quality standards. The list is called the 303(d) list because of the section of the Clean Water Act that makes the requirement.

**Adaptive management:** Monitoring or assessing the progress toward meeting objectives and incorporating what is learned into future management plans.

**Adfluvial:** Migratory between lakes and rivers or streams or, life history strategy in which adult fish spawn and juveniles subsequently rear in streams but migrate to lakes for feeding as subadults and adults. Compare fluvial.

**Administratively Withdrawn Areas:** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). Administratively Withdrawn Areas are identified in current Forest and District Plans or draft plan preferred alternatives and include recreation and visual areas, back county, and other areas where management emphasis precludes scheduled timber harvest.

**Aggradation:** The geologic process of filling and raising the level of the streambed or floodplain by deposition of material eroded and transported from other areas.

**Alevins (also sac fry or yolk-sac fry):** Larval salmonid that has hatched but has not fully absorbed its yolk sac, and generally has not yet emerged from the spawning gravel. Absorption of the yolk sac, the alevin's initial energy source, occurs as the larva develops its mouth, digestive tract, and excretory organs and otherwise prepares to feed on natural prey.

**Alluvial:** Deposited by running water.

**Alluvial fan:** A relatively flat to gently sloping landform composed of predominantly coarse grained soils, shaped like an open fan or a segment of a cone, deposited by a stream where it flows from a mountain valley onto a plain or broader valley, or wherever the stream gradient suddenly decreases. Alluvial fans typically contain several to many unconfined, distributary channels that migrate back and forth across the fan over time. This distribution of flow across several stream channels provide for less erosive water velocities, maintaining and creating suitable rearing salmonid habitat over a wide range in flows. This landform has high subsurface water storage capacity. They frequently adjoin terraces or floodplains.

**Anadromous fish:** Species that are hatched in freshwater mature in saltwater, and return to freshwater to spawn.

**Anchor ice:** Forms along the channel bottom from the accumulation of frazil ice particles on the rough surfaces of coarse bottom sediments and on the lee sides of pebble, cobbles, and boulders.

**Aquifer:**

1. A subsurface layer of rock permeable by water. Although gravel, sand sandstone and limestone are the best conveyors of water, the bulk of the earth's rock is composed of clay, shale and crystalline.
2. A saturated permeable material (often sand, gravel, sandstone or limestone) that contains or carries groundwater.
3. An underground, water-bearing layer of earth, porous rock, sand, or gravel, through which water can seep or be held in natural storage. Aquifers generally hold sufficient water to be used as a water supply.

**Basin:** The area of land that drains water, sediment and dissolved materials to a common point along a stream channel.

**Basin flow:** Portion of stream discharge derived from such natural storage sources as groundwater, large lakes, and swamps but does not include direct runoff or flow from stream regulation, water diversion, or other human activities.

**Bioengineering:** Combining structural, biological, and ecological concepts to construct living structures for erosion, sediment, or flood control.

**Biological Diversity (biodiversity):** Variety and variability among living organisms and the ecological complexes in which they occur; encompasses different ecosystems, species, and genes.

**Biotic Integrity:** Capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region; a system's ability to generate and maintain adaptive biotic elements through natural evolutionary processes.

**Braided stream:** Stream that forms an interlacing network of branching and recombining channels separated by branch islands or channel bars.

**Buffer:** An area of intact vegetation maintained between human activities and a particular natural feature, such as a stream. The buffer reduces potential negative impacts by providing an area around the feature that is unaffected by this activity.

**Capacity:** the amount of available habitat for a specific species or lifestage within a given area. Capacity is a density-dependent measure of habitat quantity.

**Carrying capacity:** Maximum average number or biomass of organisms that can be sustained in a habitat over the long term. Usually refers to a particular species, but can be applied to more than one.

**Channelization:** Straightening the meanders of a river; often accompanied by placing riprap or concrete along banks to stabilize the system.

**Channelized stream:** A stream that has been straightened, runs through pipes or revetments, or is otherwise artificially altered from its natural, meandering course.

**Channel Migration Zone:** lateral movement of channel leads to a sequence of events through time where terraces are formed and new floodplain areas are defined.

**Channel Stability:** Measure of the resistance of a stream to erosion that determines how well a stream will adjust and recover from changes in flow or sediment transport.

**Check dams:** Series of small dams placed in gullies or small streams in an effort to control erosion. Commonly built during the 1900s.

**Confinement:** When a channel is fixed in a specific location restricting its pattern of channel erosion and migration

**Confluence:** the flowing together of two or more streams, or the combined stream formed by the conjunction.

**Congressionally Reserved Areas:** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). These areas include Wildernesses, Wild and Scenic Rivers, National Monuments, as well as other federal lands not administered by the Forest Service or BLM.

**Connectivity:** Unbroken linkages in a landscape, typified by streams and riparian areas.

**Constriction:** The narrowing of a channel that impedes the downstream movement of water or debris, as in a small culvert crossing.

**Critical Stock:** A stock of fish experiencing production levels that are so low that permanent damage to the stock is likely or has already occurred.

**Depressed Stock:** A stock of fish whose production is below expected levels based on available habitat and natural variations in survival levels, but above the level where permanent damage to the stock is likely.

**Debris torrent:** A type of landslide characterized by water-charged, predominantly coarse grained soil and rock fragments, and sometimes large organic material, flowing rapidly down a pre-existing channel.

**Degradation:** The lowering of the streambed or widening of the stream channel by erosion.

**Deposition:** The settlement of material out of the water column and onto the streambed.

**Distributaries:** A river branch flowing away from the main stream.

**Diversity:** Variation that occurs in plant and animal taxa (i.e., species composition), habitats, or ecosystems. See *species richness*.

**Ecological restoration:** Involves replacing lost or damaged biological elements (populations, species) and reestablishing ecological processes (dispersal, succession) at historical rates.

**Ecosystem:** Biological community together with the chemical and physical environment with which it interacts.

**Ecosystem management:** Management that integrates ecological relationships with sociopolitical values toward the general goal of protecting or returning ecosystem integrity over the long term.

**Emigration:** to leave a place

**Endangered Species Act:** A 1973 Act of Congress that mandated the protection and restoration of endangered and threatened species of fish, wildlife and plants.

**Endangered Species:** Any species which is in danger of extinction throughout all, or a significant portion of its range, other than a species of the Class Insecta, as determined by the Secretary to constitute a pest.

**Escapement:** Those fish that have survived all fisheries and will make up a spawning population.

**Estuarine:** Of, or relating to, or formed in an estuary.

**Estuary:** A partly enclosed coastal body of water that has free connection to open sea, and within which seawater is measurably diluted by fresh river water.

**Eutrophic:** Pertaining to a lake or other body of water rich in dissolved nutrients, photosynthetically productive, and often deficient in oxygen during warm periods. Compare *oligotrophic*.

**Evolutionary Significant Unit (ESU):** A definition of a species used by National Marine Fisheries Service (NMFS) in administering the Endangered Species Act. An ESU is a population (or group of populations) that is reproductively isolated from other conspecific population units, and (2) represents an important component in the evolutionary legacy of the species.

**Extirpation:** The elimination of a species from a particular local area.

**Flood:** A rising and overflowing of a body of water especially onto normally dry land.

**Floodplain:** The low-lying, topographically flat area adjacent to a stream channel which is regularly flooded by stream water on a periodic basis and which shows evidence of the action of flowing water, such as active or inactive flood channels, recent fluvial soils, rafted debris or tree scarring. It varies in width depending on size of river, relative rates of downcutting and resistance of the bedrock in the valley walls.

**Flood-prone area:** Generally includes the active floodplain and the low terrace (Rosgen 1996).

**Flow regime:** Characteristics of stream discharge over time. Natural flow regime is the regime that occurred historically.

**Fluvial:** Of or pertaining to, or living in streams or rivers; also, organisms that migrate between main rivers and tributaries. Compare *adfluvial*.

**Frazil ice:** Thin particles of ice suspended in the water. Produced where extensive channel ice is formed and the freezing supercools the stream water producing nuclei of “frazil ice” particles.

**Genetic Diversity Unit (GDU)** is defined as: A group of genetically similar stocks that is genetically distinct from other such groups. The stocks typically exhibit similar life histories and occupy ecologically, geographically and geologically similar habitats. A GDU may consist of a single stock

**Geomorphology:** Study of the form and origins of surface features of the Earth. Geomorphology deals with the general configuration of the earth surface and the changes that take place as landforms develop (history).

**Glacial Outwash/Glacial Fluvial Outwash:** Nearly level terraces and floodplains in large valley bottoms. Slope is generally less than 10%. The terraces and floodplains were leveled by river flooding induced by melting of glaciers. They are dissected by high-energy, low-gradient, perennial streams. Channels may be braided. Channel deposits are usually comprised of moderately to well sorted sand to cobble size deposits but may include boulders. Ponds, marshes and overflow channels occur with a range of finer grained deposits. This landform is subject to frequent flooding. It has a high subsurface flow rate. Subsurface and instream flow may be in continuity. They are stable but soils on terrace escarpments may unravel. This landform commonly adjoins but can include alluvial fans and colluvial deposits along valley sides.

**Glacial Till:** A very dense, poorly sorted mixture of clay, silt, sand and gravel deposited directly beneath glacial ice.

**Glides:** Stream habitat having a slow, relatively shallow run of water with little or no surface turbulence.

**Healthy Stock:** A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock.

**Hydrologic Unit Code (HUC):** classification system used to describe the sub-division of hydrologic units. The codes represent the four levels of classification in the hydrologic unit system. The first level divides the US into 21 major geographic areas, or regions, based on surface topography, containing the drainage area of a major river or series of rivers. The second level divides the 21 regions into 222 sub-regions, which includes the area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin or, a group of streams forming a coastal drainage area. The third level subdivides many of the subregions into accounting units. These 352 units nest within, or are equivalent to, the sub-regions. The fourth level is the cataloging unit, a geographic area representing part or all of a surface drainage basin, a combination of basins, or a distinct hydrologic feature. These units subdivide the sub-regions and accounting units into approximately 2150 smaller areas.

**Hydrograph:** A graphic representation or plot of changes in the flow of water or in the elevation of water levels plotted against time.

**Hydrology:** Study of the properties, distribution, and effects of water on the Earth's surface, subsurface, and atmosphere.

**Intermittent stream:** Stream that has interrupted flow or does not flow continuously. Compare *perennial stream*.

**Interstitial spaces:** Space or openings in substrates that provide habitat and cover for bottom dwelling organisms, like young salmonids.

**Intraspecific interactions:** Interactions within a species.

**Large Woody Debris (LWD):** Any large piece of relatively stable woody material having a diameter greater than 10 cm and a length greater than 3 meters. LWD is an important part of the structural diversity of streams. The nature and abundance of LWD in a stream channel reflects past and present recruitment rates. This is largely determined by the age and composition of past and present adjacent riparian stands. Synonyms include: Large Organic Debris (LOD) and Coarse Woody Debris (CWD). Specific types of large woody debris include:

**Affixed logs:** Single logs or groups of logs that are firmly embedded, lodged, or rooted in a stream channel.

**Deadheads:** Logs that are not embedded, lodged or rooted in the stream channel but are submerged and close to the surface.

**Digger log:** Log anchored to the stream banks and/or channel bottom in such a way that a scour pool is formed.

**Free logs:** Logs or groups of logs that are not embedded, lodged or rooted in the stream channel.

**Rootwad:** The root mass of the tree.

**Snag:** A standing dead tree, or, a sometimes a submerged fallen tree in large streams. The top of the tree is exposed or only slightly submerged.

**Sweeper log:** Fallen tree whose bole or branches form an obstruction to floating objects.

**Large Woody Debris Recruitment:** The standing timber adjacent to the stream that is available to become large woody debris. Activities that disturb riparian vegetation including timber removal in riparian areas can reduce LWD recruitment. In addition, current conditions also reflect the past history of both natural and management-related channel disturbances such as flood events, debris flows, splash damming and stream clean-out.

**Lateral Moraine:** Hummocky, rolling glacial till deposits typically located in recesses along the mid-slopes of glacial trough walls. Slope is generally 25-40%. These deposits are usually not compacted. The slopes are dissected by poorly defined streams in a dendritic to deranged drainage pattern. They have a high subsurface water storage capacity and may be good shallow aquifers. Surface runoff is limited. Wet areas commonly occur in swales. Subsurface water is often diverted to depressional areas.

**Late-Successional Reserves (LSR's):** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). Late-Successional Reserves are managed to protect and enhance conditions of late-successional and old-growth forest ecosystems, which serve as habitat for late-successional and old-growth forest related species including the northern spotted owl. Limited stand management is permitted.

**Limiting Factor:** Single factor that limits a system or population from reaching its highest potential.

**Macroinvertebrates:** Invertebrates large enough to be seen with the naked eye (e.g., most aquatic insects, snails, and amphipods).

**Managed Late-Successional Reserves (MLSR):** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). Managed Late-Successional Reserves are identified for certain locations in drier provinces where regular and frequent fire is a natural part of the ecosystem. Like LSRs, MLSRs are managed to protect and enhance conditions of late-successional and

old-growth forest ecosystems, which serve as habitat for late-successional and old-growth forest related species including the northern spotted owl. Certain silvicultural treatments and fire hazard reduction treatments are allowed to help prevent complete stand destruction from large catastrophic events such as high intensity, high severity fires; or diseased or insect epidemics.

Mass wasting: Landslide processes, including debris falls, debris slides, debris avalanches, debris flows, debris torrents, rockfalls, rockslides, slumps and earthflows, and all the small scale slumping collapse and raveling of road cuts and fills.

Matrix: A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994). The matrix consists of those federal lands outside of the six categories of designated areas (Congressionally Reserved Areas, Late –Successional Reserves, Adaptive Management Areas, Managed Late-Successional Area, Administratively Withdrawn Areas, and Riparian Reserves). Most timber harvest and other silvicultural activities would be conducted in that portion of the matrix with suitable forest lands, according to standards and guidelines. Most timber harvest takes place in the matrix.

Moraine: See “Terminal Moraine”.

Native: Occurring naturally in a habitat or region; not introduced by humans.

Non-Point Source Pollution: Polluted runoff from sources that cannot be defined as discrete points, such as areas of timber harvesting, surface mining, agriculture, and livestock grazing.

Oligotrophic: water body characterized by low dissolved nutrients and organic matter, dissolved oxygen near saturation, and chlorophyll levels typically at less than 4 mg/cubic meters during the growing season.

Parr: Young trout or salmon actively feeding in freshwater; usually refers to young anadromous salmonids before they migrate to the sea. See *smolt*.

Plunge pool: A pool created by water passing over or through a complete or nearly complete channel obstruction, and dropping vertically, scouring out a basin in which the flow radiates from the point of water entry.

Pocket water: A series of small pools surrounded by swiftly flowing water, usually caused by eddies behind boulders, rubble, or logs, or by potholes in the streambed.

Pool: Portion of a stream with reduced current velocity, often with deeper water than surrounding areas and with a smooth surface.

Pool:riffle ratio: Ratio of the surface area or length of pools to the surface area or length of riffles in a given stream reach, frequently expressed as the relative percentage of each category.

**Population:** Organisms of the same species that occur in a particular place at a given time. A population may contain several discrete breeding groups or stocks.

**Productivity:** A measure of habitat quality which varies by species and lifestage. Productivity is a density-independent measure of habitat quality. Examples include, water temperature, water discharge, channel complexity, riparian condition, etc.

**Rain-on-snow events:** The rapid melting of snow as a result of rainfall and warming ambient air temperatures. The combined effect of rainfall and snow melt can cause high overland stream flows resulting in severe hillslope and channel erosion.

**Rearing habitat:** Areas required for the successful survival to adulthood by young animals.

**Recovery:** The return of an ecosystem to a defined condition after a disturbance.

**Redds:** Nests made in gravel (particularly by salmonids) for egg deposition consisting of a depression that is created and then covered.

**Rehabilitation:** Returning to a state of ecological productivity and useful structure, using techniques similar or homologous in concept; producing conditions more favorable to a group of organisms or species complex, especially that economically and aesthetically desirable flora and fauna, without achieving the undisturbed condition.

**Resident fish:** Fish species that complete their entire life cycle in freshwater.

**Riffle:** Stream habitat having a broken or choppy surface (white water), moderate or swift current, and shallow depth.

**Riparian:** Pertaining to the banks and other adjacent, terrestrial (as opposed to aquatic) environs of freshwater bodies, watercourses, and surface-emergent aquifers, whose imported waters provide soil moisture significantly in excess of that otherwise available through local precipitation – soil moisture to potentially support a mesic vegetation distinguishable from that of the adjacent more xeric upland.

**Riparian Area:** The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains which support riparian vegetation.

**Riparian Habitat Conservation Areas (RHCA):** Portions of watersheds where riparian-dependent resources receive primary emphasis, and management activities are subject to specific standards and guidelines. The RHCA's include traditional riparian corridors, wetlands, intermittent headwater streams, and other areas where proper ecological functioning is crucial to maintenance of the stream's water, sediment, woody debris and nutrient delivery systems (USFS AND BLM 1995/ PACFISH)

**Riparian Reserves:** A land management designation for federally-administered lands within the range of the northern spotted owl (USFS and BLM 1994/ Northwest Forest Plan). The Riparian Reserves provide an area along all stream, wetlands, ponds, lakes, and unstable and potentially unstable areas where riparian-dependent resources receive primary emphasis.

**Riparian Vegetation:** Terrestrial vegetation that grows beside rivers, streams and other freshwater bodies and that depends on these water sources for soil moisture greater than would otherwise be available from local precipitation.

**Riprap:** Large rocks, broken concrete, or other structure used to stabilize streambanks and other slopes.

**Rootwad:** Exposed root system of an uprooted or washed-out tree.

**Run:** An area of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

**SaSI (Salmonid Stock Inventory):** A list of Washington's naturally reproducing salmonid stocks and their origin, production type, and status. Developed in 1998 as an appendix to SASSI to include bull trout and Dolly Varden; formerly named SASSI.

**SASSI (Salmon and Steelhead Stock Inventory):** A list of Washington's naturally reproducing salmon and steelhead stocks and their origin, production type, and status; developed in 1992.

**Healthy Stocks –** A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock.

**Depressed Stocks –** A stock of fish whose production is below expected levels based on available habitat and natural variations in survival rates, but above the level where permanent damage to the stock is likely.

**Critical Stocks –** A stock of fish experiencing production levels that are so low that permanent damage to the stock is likely or has already occurred.

**Unknown Stocks –** There is insufficient information to rate stock status.

**SSHIAP (Salmon, Steelhead Habitat Inventory and Assessment Project):** A partnership based information system that characterizes distribution and freshwater habitat conditions of salmonid stocks in Washington.

**Salmonid:** Fish of the family salmonidae, including salmon, trout chars, and bull trout.

**Salmon:** Includes all species of the family Salmonid

**Sediment:** Material carried in suspension by water, which will eventually settle to the bottom.

**Sedimentation:** The process of subsidence and deposition of suspended matter carried in water by gravity; usually the result of the reduction in water velocity below the point at which it can transport the material in suspended form.

**Seral stages:** Series of relatively transitory plant communities that develop with ecological succession from bare ground to the climax plant community stage.

**Side channel:** Lateral channel with an axis of flow roughly parallel to the mainstem, which is fed by water from the mainstem; a braid of a river with flow appreciably lower than the main channel. Side channel habitat may exist either in well defined secondary (overflow) channels or in poorly defined watercourses flowing through partially submerged gravel bars and islands along the margins of the mainstem.

**Sinuosity:** Degree to which a stream channel curves or meanders laterally across the land surface. Can be determined by the ratio of the stream length to valley floor, or, the ratio of the channel length between two points on a channel to the straight line distance between the same points.

**Slope:** Water surface slope is determined by measuring the difference in water surface elevation per unit stream length. Typically measured through at least twenty channel widths or two meander wavelengths.

**Slope stability:** The degree to which a slope resists the downward pull of gravity.

**Smolt:** Juvenile salmonid, 1 or more years old, migrating seaward; a young anadromous trout, salmon, or char undergoing physiological changes that will allow it to change from life in freshwater to life in the sea. The smolt stage follows the parr stage. See *parr*.

**Stock:** Group of fish that is genetically self-sustaining and isolated geographically or temporally during reproduction. Generally, a local population of fish. More specifically, a local population – especially that of salmon, steelhead (rainbow trout), or other anadromous fish – that originates from specific watersheds as juveniles and generally returns to its birth streams to spawn as adults.

**Stream Number:** A unique six-digit numerical stream identifier, with the first two digits representing the WRIA and the last four digits representing the unique stream identifier from the WDF Stream Catalog (Williams et al. 1975) where available. For streams where the Stream Catalog does not provide a stream identified: (1) unassigned numbers in the sequence are used; or (2) an additional single-character alpha extension may be added to the end of the four-digit stream identifier for the next downstream numbered stream. Alpha extensions are generally used for tributaries to a numerically identified stream proceeding from downstream to upstream.

**Stream Order:** A classification system for streams based on the number of tributaries it has. The smallest unbranched tributary in a watershed is designated Order 1. A stream formed by the confluence of two order 1 streams is designated Order 2. A stream formed by the confluence of two order 2 streams is designated Order 3; and so on.

**Stream Reach:** a homogeneous segment of a drainage network characterized by uniform channel pattern, gradient, substrate and channel confinement.

**Substrate:** mineral and organic material forming the bottom of a waterway or water body.

**Subwatershed:** One of the smaller watersheds that combine to form a larger watershed.

**Supplementation:** the collection, rearing, and release of locally adapted salmon in ways that promote ecologic and genetic compatibility with the naturally produced fish.

**Terminal Moraine:** A low-relief, linear deposit of glacial till. These occur on valley bottoms and are laid down at the terminal end of a glacier as forward progress ends and marks the furthest extension of the glacier. Moraines have moderate to high subsurface water storage capacity.

**Terrace:** Abandoned floodplain.

**Thalweg:** The path of maximum depth in a river or stream.

**Watershed:** An area so sloped as to drain a river and all its tributaries to a single point or particular area. The total area above a given point on a watercourse that contributes water to its flow.

**Watershed restoration:** Reestablishing the structure and function of an ecosystem, including its natural diversity; a comprehensive, long-term program to return watershed health, riparian ecosystems, and fish habitats to a close approximation of their condition prior to human disturbance.

**Watershed-scale approach:** Consideration of the entire watershed in a project or plan.

**Weir:** Device across a stream to divert fish into a trap or to raise the water level or divert its flow. Also a notch or depression in a dam or other water barrier through which the flow of water is measured or regulated.

**Width-depth ratio:** Describes the dimension and shape factor as the ratio of bankfull channel width to bankfull mean depth.

**Wild Stock:** A stock that is sustained by natural spawning and rearing in the natural habitat regardless

## **APPENDIX A – FISH DISTRIBUTION MAPS**

Several maps have been included with this report for your reference. The maps are appended to the report, either as a separate electronic file (for the electronic copy of this report) or separate printed section (for hard copy). The maps are included as a separate electronic file to enable the reader to utilize computer multi-tasking capabilities to simultaneously bring up the map and associated text. Below is a list of maps that are included in the WRIA 45 and portions of WRIA 40 map appendix/file:

- A1. Spring chinook salmon distribution map in WRIA 45 and portions of WRIA 40 in Chelan County
- A2. Summer chinook salmon distribution map in WRIA 45 and portions of WRIA 40 in Chelan County
- A3. Sockeye salmon distribution map in WRIA 45 and portions of WRIA 40 in Chelan County
- A4. Summer steelhead distribution map in WRIA 45 and portions of WRIA 40 in Chelan County
- A5. Bull trout distribution map in WRIA 45 and portions of WRIA 40 in Chelan County

**APPENDIX B – FISH DISTRIBUTION TABLES**

**Appendix B 1 :Spring chinook salmon distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Big Meadow Creek	Chiwawa River	Rearing	Known	0.0 - 0.5	Spring chinook rearing from the mouth upstream to USFS Rd. 6300.
Brender Creek	Mission Creek	Rearing	Known	0.0 - 0.7	Spring chinook rearing to concrete flume below Evergreen Road (RM 0.7).
Chikamin Creek	Chiwawa River	Rearing	Known	0.0 - 6.0	Spring chinook rearing from the mouth upstream to the lower forks of Chikamin Creek (RM 6.0).
Chikamin Creek	Chiwawa River	Spawning	Known	0.0 - 0.6	Spring chinook spawning from the mouth upstream about 1/2 mile.
Chiwaukum Creek	Wenatchee River	Rearing	Known	0.0 - 4.3	Spring chinook rearing from the mouth upstream to the natural falls (RM 4.3).
Chiwaukum Creek	Wenatchee River	Spawning	Known	0.0 - 4.3	Spring chinook spawning from the mouth upstream to the natural falls (RM 4.3).
Chiwawa River	Wenatchee River	Rearing	Known	0.0 - 33.1	Spring chinook rearing from the mouth upstream to the natural falls above Buck Creek (RM 33.1).
Chiwawa River	Wenatchee River	Spawning	Known	0.0 - 33.1	Spring chinook spawning from the mouth upstream to the natural falls above Buck Creek (RM 33.1).
Chumstick Creek	Wenatchee River	Rearing	Known	0.0 - 0.3	Spring chinook rearing from the mouth upstream to the County North Road culvert (RM 0.3).
Icicle Creek	Wenatchee River	Rearing	Known	0.0 - 2.8	Spring chinook rearing from the mouth upstream to the hatchery spillway dam (RM 2.8).

**Appendix B 1 :Spring chinook salmon distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Icicle Creek	Wenatchee River	Spawning	Known	0.0 - 2.8	Spring chinook spawning from the mouth upstream to the hatchery spillway dam (RM 2.8).
Icicle Creek	Wenatchee River	Rearing	Potential/ Historic	2.8-24.0	potential/historic spring chinook rearing upstream of hatchery operations.
Icicle Creek	Wenatchee River	Spawning	Potential/ Historic	2.8-24.0	potential/historic spring chinook spawning upstream of hatchery operations.
Ingalls Creek	Peshastin Creek	Rearing	Known	0.0 - 0.5	Spring chinook rearing at the mouth.
Lake Wenatchee	Wenatchee River	Use	Known	54.2 - 58.6	Spring chinook use in Lake Wenatchee.
Little Wenatchee River	Lake Wenatchee	Rearing	Known	0.0 - 7.8	Spring chinook rearing from the mouth upstream to the natural falls (RM 7.8).
Little Wenatchee River	Lake Wenatchee	Spawning	Known	2.7-7.8	Spring chinook spawning from the old fish weir (RM 2.7) upstream to the natural falls (RM 7.8).
Mission Creek	Wenatchee River	Rearing	Known	0.0 - 1.2	Spring chinook rearing from mouth upstream to where the Icicle Irrigation District returns flow (RM 1.2).
Mission Creek	Wenatchee River	Rearing	Potential/ Historic	0.0- 10.3	Historic spring chinook rearing from the mouth upstream to Devil's Gulch (RM 10.3).
Mission Creek	Wenatchee River	Spawning	Potential/ Historic	0.0 - 10.3	Historic spring chinook spawning from the mouth upstream to Devil's Gulch(Rm 10.3).
Napeequa River	White River	Spawning	Known	0.0 - 2.2	Spring chinook occasional spawning from the mouth upstream to a natural falls barrier (RM 2.2).
Nason Creek	Wenatchee River	Rearing	Known	0.0 - 16.8	Spring chinook rearing from mouth upstream to Gaynor Falls (RM 16.8).

**Appendix B 1 :Spring chinook salmon distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Nason Creek	Wenatchee River	Spawning	Known	0.0 - 16.8	Spring chinook spawning from the mouth upstream to Gaynor Falls (RM 16.8).
Panther Creek	White River	Spawning	Known	0.0 - 0.7	Spring chinook spawning from the mouth upstream to the natural barrier falls at RM 0.7.
Panther Creek	White River	Rearing	Known	0.0 - 0.7	Spring chinook rearing from the mouth upstream to the natural barrier falls at RM 0.7.
Peshastin Creek	Wenatchee River	Rearing	Known	0.0 - 14.8	Spring chinook rearing from the mouth upstream to the confluence of Magnet Creek (RM 14.8).
Peshastin Creek	Wenatchee River	Spawning	Known	5.2 - 9.4	Spring chinook spawning from the confluence of Mill Creek (RM 5.2) upstream to the confluence of Ingalls Creek (RM 9.4).
Phelps Creek	Chiwawa River	Rearing	Known	0.0 - 1.0	Spring chinook rearing from the mouth upstream to the natural falls (RM 1.0).
Rock Creek	Chiwawa River	Spawning	Known	0.0 - 0.5	Spring chinook Spawning in lower 0.5 miles.
Rock Creek	Chiwawa River	Rearing	Known	0.0 - 5.5	Spring chinook rearing to a log dam/bedrock chute (RM 5.5).
Sand Creek	Mission Creek	Rearing	Potential/ Historic	0.0 - 2.2	Historic spring chinook rearing to 1/2 mile above the Little Camas Creek confluence (RM 2.2).
Skinney Creek	Chiwaukum Creek	Rearing	Known	0.0 - 0.25	Spring chinook rearing to USFS culvert at RM 0.25.
Squilchuck Creek	Columbia River	Rearing	Known	0.0 - 0.3	Spring chinook rearing from the mouth upstream to the S. Wenatchee Ave. culvert (RM 0.3).

**Appendix B 1 :Spring chinook salmon distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Stemilt Creek	Columbia River	Rearing	Known	0.0 - 1.0	Spring chinook rearing from the mouth upstream to RM 1.0.
Wenatchee River	Columbia River	Rearing	Known	0.0 - 54.2	Spring chinook rearing from the mouth upstream to the outlet of Lake Wenatchee (54.2).
Wenatchee River	Columbia River	Spawning	Known	35.6 - 54.2	Spring chinook spawning from the top of Tumwater Canyon (RM 35.6) upstream to Lake Wenatchee (RM 54.2).
White River	Lake Wenatchee	Rearing	Known	0.0 - 14.3	Spring chinook rearing from the mouth upstream to White River Falls (RM 14.3).
White River	Lake Wenatchee	Spawning	Known	0.0 - 14.3	Spring chinook spawning from the mouth upstream to White River Falls (RM 14.3), with the primary spawning area being from Sears Creek bridge (RM 6.4) to White River Falls (RM 14.3)

**Appendix B 2: Summer chinook salmon distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Wenatchee River	Columbia River	Rearing	Known	0.0 - 54.2	Summer chinook rearing from the mouth upstream to Lake Wenatchee
Wenatchee River	Columbia River	Spawning	Known	0.0 - 54.2	Summer chinook spawning from the mouth upstream to Lake Wenatchee.

**Appendix B 3: Sockeye salmon distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Icicle Creek	Wenatchee River	Rearing	Known	0.0 - 2.8	Sockeye rearing from mouth upstream to hatchery spillway dam RM 2.8.
Icicle Creek	Wenatchee River	Spawning	Known	0.0 - 2.8	Sockeye spawning from mouth upstream to hatchery spillway dam RM 2.8.
Lake Wenatchee	Wenatchee River	Rearing	Known	54.2 - 58.6	Sockeye rearing in Lake Wenatchee.
Little Wenatchee River	Lake Wenatchee	Rearing	Known	0.0 - 5.6	Sockeye rearing to confluence of Line Creek (RM 5.6).
Little Wenatchee River	Lake Wenatchee	Spawning	Known	0.0 - 5.6	Sockeye spawning to confluence of Line Creek (RM 5.6).
Little Wenatchee River	Lake Wenatchee	Spawning	Presumed	5.6 - 7.8	Presumed sockeye spawning up to natural barrier falls (RM 7.8).
Napeequa River	White River	Spawning	Known	0.0 - 2.2	Sockeye spawning from mouth upstream to natural falls (RM 2.2).
Wenatchee River	Columbia River	Migration	Known	0.0 - 54.2	Migration from the Lake Wenatchee outlet downstream to the Columbia River.
White River	Lake Wenatchee	Rearing	Known	0.0 - 12.9	Sockeye rearing to Grasshopper Meadows (RM 12.9).
White River	Lake Wenatchee	Spawning	Known	0.0 - 12.9	Sockeye spawning to Grasshopper Meadows (RM 12.9).

**Appendix B 4: Summer steelhead distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Beaver Creek	Wenatchee River	Anadromy	Known	0.0 - 0.3	Susthd anadromy from mouth upstream to culvert (RM 0.3).
Beaver Creek	Wenatchee River	Anadromy	Potential	0.3 - 1.9	Potential SuSthd anadromy to County Road culvert at RM 0.3.
Big Meadow Creek	Chiwawa River	Anadromy	Known	0.0 - 0.5	SuSthd anadromy from mouth upstream to USFS Rd. 6300 (RM 0.5).
Brender Creek	Mission Creek	Anadromy	Known	0.0 - 0.7	SuSthd anadromy from mouth upstream to concrete flume below Evergreen Road (RM 0.7).
Buck Creek	Chiwawa River	Anadromy	Known	0.0 - 0.4	SuSthd anadromy from mouth upstram to natural barrier at RM 0.4.
Cabin Creek	Wenatchee River	Anadromy	Known		SuSthd anadromy
Chikamin Creek	Chiwawa River	Anadromy	Known	0.0 - 6.0	SuSthd anadromy from the mouth upstream to the lower forks of Chikamin (6.0).
Chiwaukum Creek	Wenatchee River	Anadromy	Known	0.0 - 4.3	SuSthd anadromy from mouth upstrem to natural falls (RM 4.3).
Chiwawa River	Wenatchee River	Anadromy	Known	0.0 - 33.1	SuSthd anadromy from the mouth upstream to the natural falls above Buck Creek(RM 33.1).
Chumstick Creek	Wenatchee River	Anadromy	Known	0.0 - 5.7	SuSthd anadromy from the mouth upstream to approximately RM 5.7.
Colockum Creek	Columbia River	Anadromy	Known	0.0 - 3.8	SuSthd anadromy from mouth upstream Kingsbury Canyon.
Derby Canyon	Wenatchee River	Anadromy	Known	0.0 - 3.1	SuSthd anadromy from mouth upstream to Beaver ponds (RM 3.1).
Eagle Creek	Chumstick Creek	Anadromy	Known		SuSthd anadromy

**Appendix B 4: Summer steelhead distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
East Fork Mission Creek	Mission Creek	Anadromy	Known		SuSthd anadromy
Gill Creek	Nason Creek	Anadromy	Known		SuSthd anadromy
Icicle Creek	Wenatchee River	Anadromy	Known	0.0 - 2.8	SuSthd anadromy from the mouth upstream to the hatchery spillway dam (RM 2.8).
Icicle Creek	Wenatchee River	Anadromy	Potential/historic	2.8-23.55	potential/historic SuSthd anadromy above hatchery spillway dam (RM 2.8).
Ingalls Creek	Peshastin Creek	Anadromy	Known	0.0 - 9.8	SuSthd anadromy from the mouth upstream to the natural falls (RM 9.8).
Kahler Creek	Nason Creek	Anadromy	Known		SuSthd anadromy
King Canyon	E. Fk. Mission Creek	Anadromy	Known		SuSthd anadromy
Lake Wenatchee	Wenatchee River	Anadromy	Known	54.2 - 58.6	SuSthd use in Lake Wenatchee
Little Camas Creek	Sand Creek	Anadromy	Known		SuSthd anadromy
Little Wenatchee River	Lake Wenatchee	Anadromy	Known	0.0 - 7.8	SuSthd anadromy from the mouth upstream to the natural falls (RM 7.8).
Middle Shaser Creek	Shaser Creek	Anadromy	Known		SuSthd anadromy
Mill Creek	Peshastin Creek	Anadromy	Known		SuSthd anadromy
Mission Creek	Wenatchee River	Anadromy	Known	0.0 - 10.3	SuSthd anadromy to Devil's Gulch (RM 10.3).
Napeequa River	White River	Anadromy	Known	0.0 - 2.2	SuSthd anadromy to natural falls (RM 2.2).

**Appendix B 4: Summer steelhead distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Nason Creek	Wenatchee River	Anadromy	Known	0.0 - 20.53	SuSthd anadromy to Bygone Byways (RM 20.5).
Negro Creek	Peshastin Creek	Anadromy	Known	0.0 - 2.7	SuSthd anadromy to natural falls (RM 2.7).
North Shaser Creek	Shaser Creek	Anadromy	Known	0.0 - 1.7	SuSthd anadromy to 5 foot falls at rmi 1.7
Panther Creek	White River	Anadromy	Known	0.0 - 0.7	SuSthd anadromy to series of 3 falls (RM 0.7).
Peshastin Creek	Wenatchee River	Anadromy	Known		SuSthd anadromy
Phelps Creek	Chiwawa River	Anadromy	Known	0.0 - 1.0	SuSthd anadromy to barrier falls 1.0
Roaring Creek	Nason Creek	Anadromy	Known	0.0 - 1.0	SuSthd anadromy to falls (RM 1.0).
Rock Creek	Chiwawa River	Anadromy	Known	0.0 - 5.5	SuSthd anadromy to log dam/bedrock chute (RM 5.5).
Ruby Creek	Peshastin Creek	Anadromy	Known	0.0 - 1.48	SuSthd anadromy to culvert (RM 1.48).
Sand Creek	Mission Creek	Anadromy	historic	0.0 - 2.2	historic SuSthd anadromy to 1/2 mile above Little Camas Creek(RM 2.2).
Scotty Creek	Peshastin Creek	Anadromy	Known		SuSthd anadromy
Skinney Creek	Chiwaukum Creek	Anadromy	Known	0.0 - 0.25	SuSthd anadromy to USFS culvert at 0.25 miles
Skinney Creek	Chiwaukum Creek	Anadromy	Potential	0.0 - 3.14	SuSthd potential use up to beaver ponds at RM 3.14, and possibly beyond.
Squilchuck Creek	Columbia River	Anadromy	Known	0.0 - 0.3	SuSthd anadromy from mouth upstream to culvert at S. Wenatchee Avenue (RM 0.3).

**Appendix B 4: Summer steelhead distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Stemilt Creek	Columbia River	Anadromy	Known	0.0 - 1.0	SuSthd anadromy from mouth upstream to RM 1.0.
Tronsen Creek	Peshastin Creek	Anadromy	Known	0.0 - 6.0	SuSthd anadromy to State Hwy. 97 culvert (RM 6.0).
Wenatchee River	Columbia River	Anadromy	Known	0.0 - 54.2	sthd anadromy from mouth upstream to Lake Wenatchee.
White River	Lake Wenatchee	Anadromy	Known	0.0 - 14.3	SuSthd anadromy from the mouth upstream to the White River Falls (RM 14.3).
Whitepine Creek	Nason Creek	Anadromy	Known	0.0 - 0.5	SuSthd anadromy to 20 foot natural barrier falls (RM 0.5.).

**Appendix B 5: Bull trout distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Alpine Creek	Chiwawa River	Spawning	Known	0.0 - 0.1	Bull trout spawning.
Beaver Creek	Wenatchee River	Use	Known	0.0 - 0.3	Bull trout use to culvert (RM 0.3).
Buck Creek	Chiwawa River	Rearing	Known	0.0 - 0.4	Bull trout trout rearing to natural barrier at RM 0.4.
Buck Creek	Chiwawa River	Spawning	Known	0.0 - 0.4	Bull trout trout spawning to natural barrier at RM 0.4.
Canyon Creek	White River	Rearing	Known	0.0 - 0.19	Bull trout trout rearing.
Canyon Creek	White River	Spawning	Known	0.0 - 0.19	Bull trout trout spawning.
Chikamin Creek	Chiwawa River	Rearing	Known	0.0 - 6.7	Bull trout trout rearing to fish impassable culvert on USFS Rd. 6210.
Chikamin Creek	Chiwawa River	Spawning	Known	0.0 - 6.7	Bull trout spawning to fish impassable culvert on USFS Rd. 6210.
Chiwaukum Creek	Wenatchee River	Spawning	Known	0.0 - 4.3	Bull trout spawning to natural falls (RM 4.3).
Chiwaukum Creek	Wenatchee River	Rearing	Known	0.0 - 4.3	Bull trout rearing to natural falls (RM 4.3).
Chiwaukum Creek	Wenatchee River	Use	Known	4.3 – 6.5	Bull trout use to second natural falls (RM 6.5).
Chiwawa River	Wenatchee River	Use	Known	0.0 – 13.7	Bull trout use from the mouth upstream to the Chikamin Creek confluence (RM 13.7).

**Appendix B 5: Bull trout distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Chiwawa River	Wenatchee River	Rearing	Known	13.7 - 33.1	Bull trout rearing from the Chikamin Creek confluence (RM 13.7) to natural falls upstream of the Buck Creek confluence (RM 33.1).
Chiwawa River	Wenatchee River	Spawning	Known	13.7 - 33.1	Bull trout spawning from Chikamin Creek confluence (RM 13.7) to natural falls upstream of the Buck Creek confluence (RM 33.1).
Eightmile Creek	Icicle River	Use	Known	0.0 - 0.5	Bull trout rearing to natural barrier at RM 0.5.
French Creek	Icicle River	Rearing	Known	0.0 - 3.5	Bull trout rearing to RM 3.5, above Trail 1564A.
Icicle Creek	Wenatchee River	Use	Known	0.0 - 2.8	Adult bull trout have been observed in Icicle Creek up to the hatchery spillway dam (RM 2.8).
Icicle Creek	Wenatchee River	Use	Potential/ Historic	2.8-23.55	potential/historic bull trout use above hatchery spillway dam (RM 2.8).
Ingalls Creek	Peshastin Creek	Use	Known	0.0 - 9.8	Bull trout use to natural falls at RM 9.8.
Jack Creek	Icicle River	Use	Known	0.0 - 2.41	Bull trout use.
James Creek	Chiwawa River	Spawning	Known	0.0 - 0.25	Bull trout spawning.
James Creek	Chiwawa River	Rearing	Known	0.0 - 0.25	Bull trout rearing.
Lake Wenatchee	Wenatchee River	Use	Known	54.2 - 58.6	Bull trout use in Lake Wenatchee.
Little Wenatchee River	Lake Wenatchee	Rearing	Known	0.0 - 7.8	Bull trout rearing from mouth upstream to natural falls (RM 7.8).

**Appendix B 5: Bull trout distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Little Wenatchee River	Lake Wenatchee	Spawning	Known	2.3 - 7.8	Bull trout spawning from approximately RM 2.3 upstream to the natural falls (RM 7.8).
Mill Creek	Nason Creek	Rearing	Known	0.0 - 0.28	Bull trout rearing, to WDOT culvert under State Hwy 2 westbound.
Mill Creek	Nason Creek	Spawning	Known	0.0 - 0.28	Bull trout spawning, to WDOT culvert under State Hwy 2 westbound.
Napeequa River	White River	Use	Known	0.0 - 2.2	Bull trout use to natural falls (RM 2.2); adults observed downstream of falls.
Nason Creek	Wenatchee River	Rearing	Known	0.0 - 20.53	Bull trout rearing to Bygone Byways (RM 20.5).
Nason Creek	Wenatchee River	Spawning	Known	0.0 - 20.53	Bull trout spawning to Bygone Byways (RM 20.5).
Panther Creek	White River	Rearing	Known	0.0 - 0.7	Bull trout rearing to series of 3 falls at RM 0.7.
Panther Creek	White River	Spawning	Known	0.0 - 0.7	Bull trout spawning to series of 3 falls (RM 0.7).
Peshastin Creek	Wenatchee River	Use	Known	0.0 - 1.42	Bull trout use in lower 1.42 mile reach.
Peshastin Creek	Wenatchee River	Use	Potential/ Historic	0.0 - headwaters	Bull trout use to headwaters.
Phelps Creek	Chiwawa River	Rearing	Known	0.0 - 1.0	Bull trout rearing to barrier falls (RM 1.0).
Phelps Creek	Chiwawa River	Spawning	Known	0.0 - 1.0	Bull trout spawning to barrier falls (RM 1.0).

**Appendix B 5: Bull trout distribution table in WRIA 45 and portions of WRIA 40 in Chelan County**

<b>STREAM</b>	<b>TRIBUTARY TO</b>	<b>SPECIES USE</b>	<b>STATUS</b>	<b>EXTENT (RM)</b>	<b>COMMENTS</b>
Rainy Creek	Little Wenatchee River	Use	Presumed	2.7 - 5.5	Presumed bull trout use to barrier falls (RM 5.5).
Rainy Creek	Little Wenatchee River	Use	Known	0.0 - 2.7	Known bull trout use to 0.3 miles downstream of USFS Rd. 6700 (RM 2.7).
Rock Creek	Chiwawa River	Rearing	Known	0.0 - 5.5	Bull trout rearing to log dam/bedrock chute at RM 5.5.
Rock Creek	Chiwawa River	Spawning	Known	0.0 - 5.5	Bull trout spawning to log dam/bedrock chute at RM 5.5.
Sears Creek	White River	Rearing	Known	0.0 - 0.35	Bull trout rearing from mouth upstream to USFS Rd. 6404 (RM 0.35).
Wenatchee River	Columbia River	Rearing	Known	0.0 - 54.2	Bull trout rearing from the mouth upstream to Lake Wenatchee.
White River	Lake Wenatchee	Rearing	Known	0.0 - 14.3	Bull trout rearing from mouth upstream to White River Falls (RM 14.3).
White River	Lake Wenatchee	Spawning	Known	0.0 - 14.3	Bull trout spawning from the mouth upstream to White River Falls (RM 14.3).

**Table C1: \* Historical counts of spring chinook redds in the Wenatchee subbasin, 1958-1999**

Year	Redd Counts						Total	% of Total Counts (Icicle Included)						Total Redds	% of Total Counts (Icicle Excluded)				
	White River	Little Wentachee	Chiwawa	Nason	Icicle	Upper Wenatchee		White River	Little Wentachee	Chiwawa	Nason	Icicle	Upper Wenatchee		White River	Little Wentachee	Chiwawa	Nason	Upper Wenatchee
1958	24	27	142	136	9	0	338	7.10%	7.99%	42.01%	40.24%	2.66%	0.00%	329	7.29%	8.21%	43.16%	41.34%	0.00%
1959	5	19	91	116	30	42	303	1.65%	6.27%	30.03%	38.28%	9.90%	13.86%	273	1.83%	6.96%	33.33%	42.49%	15.38%
1960	21	10	251	248	50	27	607	3.46%	1.65%	41.35%	40.86%	8.24%	4.45%	557	3.77%	1.80%	45.06%	44.52%	4.85%
1961	11	28	85	131	19	22	296	3.72%	9.46%	28.72%	44.26%	6.42%	7.43%	277	3.97%	10.11%	30.69%	47.29%	7.94%
1962	32	51	154	248	14	34	533	6.00%	9.57%	28.89%	46.53%	2.63%	6.38%	519	6.17%	9.83%	29.67%	47.78%	6.55%
1963	13	30	207	108	38	30	426	3.05%	7.04%	48.59%	25.35%	8.92%	7.04%	388	3.35%	7.73%	53.35%	27.84%	7.73%
1964	29	44	181	265	62	32	613	4.73%	7.18%	29.53%	43.23%	10.11%	5.22%	551	5.26%	7.99%	32.85%	48.09%	5.81%
1965	31	75	255	259	20	27	667	4.65%	11.24%	38.23%	38.83%	3.00%	4.05%	647	4.79%	11.59%	39.41%	40.03%	4.17%
1966	34	138	605	337	28	32	1174	2.90%	11.75%	51.53%	28.71%	2.39%	2.73%	1146	2.97%	12.04%	52.79%	29.41%	2.79%
1967	90	93	297	203	44	56	783	11.49%	11.88%	37.93%	25.93%	5.62%	7.15%	739	12.18%	12.58%	40.19%	27.47%	7.58%
1968	35	73	439	384	52	32	1015	3.45%	7.19%	43.25%	37.83%	5.12%	3.15%	963	3.63%	7.58%	45.59%	39.88%	3.32%
1969	57	20	459	275	9	33	853	6.68%	2.34%	53.81%	32.24%	1.06%	3.87%	844	6.75%	2.37%	54.38%	32.58%	3.91%
1970	6	11	421	164	11	44	657	0.91%	1.67%	64.08%	24.96%	1.67%	6.70%	646	0.93%	1.70%	65.17%	25.39%	6.81%
1971	48	20	114	37	20	0	239	20.08%	8.37%	47.70%	15.48%	8.37%	0.00%	219	21.92%	9.13%	52.05%	16.89%	0.00%
1972	59	32	215	92	21	61	480	12.29%	6.67%	44.79%	19.17%	4.38%	12.71%	459	12.85%	6.97%	46.84%	20.04%	13.29%
1973	51	78	427	368	11	43	978	5.21%	7.98%	43.66%	37.63%	1.12%	4.40%	967	5.27%	8.07%	44.16%	38.06%	4.45%
1974	37	20	87	183	120	1	448	8.26%	4.46%	19.42%	40.85%	26.79%	0.22%	328	11.28%	6.10%	26.52%	55.79%	0.30%
1975	22	14	229	254	178	0	697	3.16%	2.01%	32.86%	36.44%	25.54%	0.00%	519	4.24%	2.70%	44.12%	48.94%	0.00%
1976	36	19	220	103	138	18	534	6.74%	3.56%	41.20%	19.29%	25.84%	3.37%	396	9.09%	4.80%	55.56%	26.01%	4.55%
1977	39	0	293	94	15	46	487	8.01%	0.00%	60.16%	19.30%	3.08%	9.45%	472	8.26%	0.00%	62.08%	19.92%	9.75%
1978	44	27	279	233	55	39	677	6.50%	3.99%	41.21%	34.42%	8.12%	5.76%	622	7.07%	4.34%	44.86%	37.46%	6.27%
1979	0	0	59	70	89	27	245	0.00%	0.00%	24.08%	28.57%	36.33%	11.02%	156	0.00%	0.00%	37.82%	44.87%	17.31%
1980	0	22	119	66	91	16	314	0.00%	7.01%	37.90%	21.02%	28.98%	5.10%	223	0.00%	9.87%	53.36%	29.60%	7.17%
1981	18	36	187	105	18	26	390	4.62%	9.23%	47.95%	26.92%	4.62%	6.67%	372	4.84%	9.68%	50.27%	28.23%	6.99%
1982	52	57	178	107	21	1	416	12.50%	13.70%	42.79%	25.72%	5.05%	0.24%	395	13.16%	14.43%	45.06%	27.09%	0.25%
1983	89	65	313	216	15	3	701	12.70%	9.27%	44.65%	30.81%	2.14%	0.43%	686	12.97%	9.48%	45.63%	31.49%	0.44%
1984	52	64	348	98	43	16	621	8.37%	10.31%	56.04%	15.78%	6.92%	2.58%	578	9.00%	11.07%	60.21%	16.96%	2.77%
1985	119	55	507	209	17	91	998	11.92%	5.51%	50.80%	20.94%	1.70%	9.12%	981	12.13%	5.61%	51.68%	21.30%	9.28%
1986	61	42	320	95	26	92	636	9.59%	6.60%	50.31%	14.94%	4.09%	14.47%	610	10.00%	6.89%	52.46%	15.57%	15.08%
1987	44	81	444	135	55	42	801	5.49%	10.11%	55.43%	16.85%	6.87%	5.24%	746	5.90%	10.86%	59.52%	18.10%	5.63%
1988	62	64	295	141	58	76	696	8.91%	9.20%	42.39%	20.26%	8.33%	10.92%	638	9.72%	10.03%	46.24%	22.10%	11.91%
1989	62	45	314	98	24	94	637	9.73%	7.06%	49.29%	15.38%	3.77%	14.76%	613	10.11%	7.34%	51.22%	15.99%	15.33%
1990	22	30	255	103	50	36	496	4.44%	6.05%	51.41%	20.77%	10.08%	7.26%	446	4.93%	6.73%	57.17%	23.09%	8.07%
1991	21	18	104	67	40	41	291	7.22%	6.19%	35.74%	23.02%	13.75%	14.09%	251	8.37%	7.17%	41.43%	26.69%	16.33%
1992	35	35	302	81	37	38	528	6.63%	6.63%	57.20%	15.34%	7.01%	7.20%	491	7.13%	7.13%	61.51%	16.50%	7.74%
1993	60	61	106	134	53	86	500	12.00%	12.20%	21.20%	26.80%	10.60%	17.20%	447	13.42%	13.65%	23.71%	29.98%	19.24%
1994	3	7	82	27	15	6	140	2.14%	5.00%	58.57%	19.29%	10.71%	4.29%	125	2.40%	5.60%	65.60%	21.60%	4.80%
1995	2	0	13	7	9	1	32	6.25%	0.00%	40.63%	21.88%	28.13%	3.13%	23	8.70%	0.00%	56.52%	30.43%	4.35%
1996	12	3	23	33	12	1	84	14.29%	3.57%	27.38%	39.29%	14.29%	1.19%	72	16.67%	4.17%	31.94%	45.83%	1.39%
1997	15	8	82	55	33	15	208	7.21%	3.85%	39.42%	26.44%	15.87%	7.21%	175	8.57%	4.57%	46.86%	31.43%	8.57%
1998	5	8	41	29	11	0	94	5.32%	8.51%	43.62%	30.85%	11.70%	0.00%	83	6.02%	9.64%	49.40%	34.94%	0.00%
1999	1	3	34	8	6	2	54	1.85%	5.56%	62.96%	14.81%	11.11%	3.70%	48	2.08%	6.25%	70.83%	16.67%	4.17%
Totals:	1459	1533	9577	6122	1667	1329	21687	6.73%	7.07%	44.16%	28.23%	7.69%	6.13%	20020	7.29%	7.66%	47.84%	30.58%	6.64%

\* Chelan County Public Utilities District spawning ground surveys database.

## **APPENDIX D - SALMONID HABITAT RATING CRITERIA**

Under RCW 77.85, the Salmon Recovery Act (passed by the legislature as House Bill 2496, and later revised by Senate Bill 5595), the Washington Conservation Commission (WCC) is charged with identifying the habitat factors limiting the production of salmonids throughout the state. This information is intended as a tool to guide Lead Entity groups and the Salmon Recovery Funding Board (SRFB) in prioritizing salmonid habitat restoration and protection projects seeking state and federal funds. Identifying the extent to which a habitat factor may be limiting salmonid productivity requires a set of habitat rating criteria. These criteria can then be used to assess the functioning condition of selected habitat factors. In turn, this information can be used to promote an understanding of the relative significance of different habitat factors and allow for consistency in evaluating habitat conditions in each WRIA throughout the state.

In order to develop a set of criteria to rate salmonid habitat conditions, several tribal, state, and federal documents that use some type of habitat rating system (Table D1) were reviewed by the WCC in 1998 (Table D2). The goal was to identify appropriate rating standards for as many types of habitat limiting factors as possible, with an emphasis on those that could be applied to readily available data. Based on the review, it was decided to rate habitat conditions into three categories: Good, Fair, and Poor. For habitat factors that had wide agreement on how to rate habitat condition, the accepted standard was adopted by the WCC for the purpose of the assessment exercise. For factors that had a range of standards, one or more of them were adopted. Where no standard could be found, a default rating standard was developed by WCC, with the expectation that it will be modified or replaced as better data become available. It was anticipated that WRIA 2496 Technical Advisory Groups (TAGs) may modify or replace the criteria where: local conditions warrant deviation from the rating standards identified in the review; where it was the consensus of the TAG that alternate criteria were more appropriate for their WRIA; or where habitat factors were selected for assessment by the TAG for which the WCC had not identified rating criteria. The Wenatchee Watershed 2496 Salmonid Habitat Limiting Factors TAC Habitat Rating Criteria are presented in Table D3. In the event criteria were modified, replaced or added, the TAG is required to provide the source from which the criteria was derived. These ratings are not intended to be used as thresholds for regulatory purposes, but as a coarse screen to identify the most significant habitat limiting factors in a WRIA. They will provide a level of consistency between WRIs that allows habitat conditions to be compared across the state.

**Table D1: Source Documents**

<b>Code</b>	<b>Document</b>	<b>Organization</b>
Hood Canal	Hood Canal/Eastern Strait of Juan de Fuca Summer Chum Habitat Recovery Plan, Final Draft (1999)	Point No Point Treaty Council, Skokomish Tribe, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Washington Department of Fish and Wildlife
ManTech	An Ecosystem Approach to Salmnoid Conservation, vol. 1 (1995)	ManTech Environmental Research Services for the National Marine Fisheries Service, the US Environmental Protection Agency, and the US Fish and Wildlife Service
NMFS	Coastal Salmon Conservation: Working Guidance for Comprehensive Salmon Restoration Initiatives on the Pacific Coast (1996)	National Marine Fisheries Service
PHS	Priority Habitat Management Recommendations: Riparian (1995)	Washington Department of Fish and Wildlife
Skagit	Skagit Watershed Council Habitat Protection and Restoration Strategy (1998)	Skagit Watershed Council
WSA	Watershed Analysis Manual, v4.0 (1997)	Washington Forest Practices Board
USFWS Guidelines	A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale	Fish and Wildlife Service
NMFS Criteria	Juvenile Fish Screen Criteria and the Addendum for Juvenile Fish Screen Criteria for Pump Intakes.	National Marine Fisheries Service
TAC	The assessment of conditions are based on professional knowledge of the system	2496 Wenatchee Habitat Limiting Factors Technical Advisory Committee (TAC)
WSP	Wild Salmonid Policy (1997)	Washington Department of Fish and Wildlife

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
<b>Fine Sediment</b>	WSP	Fines < 0.85 mm in spawning gravel	All (except where natural values exceed 11%)	-	-	? 11%
	WSA	Fines < 0.85 mm in spawning gravel	All	>17%	12-17%	<12%
	NMFS	Fines < 0.85 mm in spawning gravel	All – Westside	>17%	12-17%	<12%
		Fines < 0.85 mm in spawning gravel	All – Eastside	>20%	12-20%	<12%
	Skagit		All (Westside only)	Use B-IBI		
	Hood Canal	Fines < 0.85 mm in spawning gravel	All (Westside only)	>17%	12-20%	<12%
<b>Large Woody Debris</b>	WSP/WSA	pieces/channel width	<20 m wide	<1	1-2	2-4
		key pieces/channel width*	<10 m wide (Westside only)	<0.15	0.15-0.30	>0.30
		key pieces/channel width*	10-20 m wide (Westside only)	<0.20	0.20-0.50	>0.50

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
		* Minimum size to qualify as a key piece:		BFW (m) 0-5 6-10 11-15 16-20	Diameter (m) 0.4 0.55 0.65 0.7	Length (m) 8 10 18 24
	NMFS	pieces/mile >24" dia. and >50' length	All – Westside	Does not meet standard and does not have sufficient recruitment potential from riparian stand	Meets standard, but does not have sufficient recruitment potential from riparian stand	>80 and has sufficient recruitment potential from riparian stand
		pieces/mile >12" dia. and >35' length	All – Eastside	Does not meet standard and does not have sufficient recruitment potential from riparian stand	Meets standard, but does not have sufficient recruitment potential from riparian stand	>20 and has sufficient recruitment potential from riparian stand
	Skagit	pieces/m channel length	? 4% gradient, <15 m wide (Westside only)	-	-	>0.4

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
<b>Percent Pool</b>	Hood Canal	pieces/m channel length	?4% gradient, <15 m wide (Westside only)	<0.2	0.2-0.4	>0.4
	WSP/WSA	% pool, by surface area	<2% gradient, < 15 m wide	<40%	40-55%	>55%
		% pool, by surface area	2-5% gradient, <15 m wide	<30%	30-40%	>40%
		% pool, by surface area	>5% gradient, <15 m wide	<20%	20-30%	>30%
	NMFS			-	-	-
	Skagit			-	-	-
	Hood Canal	% pool, by surface area	<15 m	<40%	40-55%	>55%
		% pool, by surface area	>15 m	<35%	35-50%	>50%
	<b>Pool Frequency</b>	WSP/WSA	channel widths per pool	<15 m wide	>4	2-4

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
	NMFS	channel pools/ width mile 5' 184 10' 96 15' 70 20' 56 25' 47 50' 26 75' 23 100' 18		does not meet pool frequency standards (left)	meets pool frequency standards (left), but large woody debris recruitment is inadequate to maintain pools over time	meets pool frequency standards (left) and meets large woody debris standards (above)
	Skagit					
	Hood Canal	channel widths per pool	<15 m	<2	2-4	>4
<b>Pool Quality</b>	WSP/WSA	Pools/km >1 m deep with good cover and cool water	All	Few deep pools	-	Sufficient deep pools
	NMFS	pools >1 m deep with good cover and cool water	All	No deep pools and inadequate cover or temperature, major reduction of pool volume by fine sediment	Few deep pools or inadequate cover or temperature, moderate reduction of pool volume by fine sediment	Sufficient deep pools
	Skagit			-	-	-

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
	Hood Canal			-	-	-
<b>Temperature</b>	WSP (Same as State Water Quality Standards)	degrees Celsius	Class AA	-	-	? 16? C
		degrees Celsius	Class A	-	-	? 18? C
		degrees Celsius	Class B	-	-	? 21? C
	WSA	% shade	Class A and AA only	Need sufficient shade to meet water quality standards		
	NMFS	degrees Celsius	All	>15.6? C (spawning) >17.8? C (migration and rearing)	14-15.6? C (spawning) 14-17.8? C (migration and rearing)	10-14? C
	Skagit			-	-	-
	Hood Canal	degrees Celsius		>12? C	-	<12? C

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
<b>Fish Passage</b>	WSP		All	-	-	Free and unobstructed passage for all wild salmonids, and ?95% survival for passage through dams and diversions
	WSA		All	Access blocked by low water, culvert, falls, temperature, etc.	-	No blockages
	NMFS		All	any artificial barriers present do not allow upstream and/or downstream passage at all flows	any artificial barriers present do not allow upstream and/or downstream passage at low flows	any artificial barriers present provide upstream and downstream passage at all flows
	Skagit			-	-	-
	Hood Canal		All			Unobstructed passage
<b>Flow</b>	WSP	% impervious surface	All	>5-10%	-	-

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
		hydrologic maturity	All	-	-	>60% of standing timber at age 25 or more
	WSA	hydrologic maturity	All	hydrologic modeling exercise focused on rain-on-snow zone		
	NMFS	hydrograph change	All	pronounced changes in peak flow, baseflow and/or flow timing relative to an undisturbed reference watershed	some evidence of altered peak flow, baseflow and/or flow timing relative to an undisturbed reference watershed	watershed hydrograph indicates peak flow, base flow and flow timing are comparable to an undisturbed reference watershed
		drainage network density	All	significant increases in drainage network density due to roads (e.g. 20-25%)	moderate increases in drainage network density due to roads (e.g. 5%)	zero or minimum increases in drainage network density due to roads
	Skagit	% impervious area	Lowland basins	>10%	3-10%	?3%

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
		hydrograph change	Forested mountain basins	2-yr flood magnitude exceeds 5-yr flood magnitude under natural conditions		
		Range of Variability Approach	All	change greater than one standard deviation from annual 7-day minimum flow or of the annual peak flow		
	Hood Canal	% impervious surface		>5%		
		hydrologic maturity		<60% of a watershed in native forest vegetation		
<b>Sediment Supply/Mass Wasting</b>	WSP			-	-	-
	WSA					No increase in mass wasting events over natural levels
	NMFS			-	-	-

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
	Skagit	m <sup>3</sup> /km <sup>2</sup> /yr	All	> 100 or exceeds natural rate		< 100 or does not exceed natural rate
	Hood Canal			-	-	-
<b>Roads</b>	WSP			-	-	-
	WSA			?	?	?
	NMFS	mi/mi <sup>2</sup>	All	>3 with many valley bottom roads	2-3 with some valley bottom roads	<2 with no valley bottom roads
	Skagit			-	-	-
	Hood Canal			-	-	-
<b>Riparian</b>	WSP	buffer width	Type 1-3 and untyped salmonid streams >5' wide			Mature native vegetation. Buffer should be 100-150' or site potential tree height (whichever is greater) measured horizontally out from channel migration zone on each side.

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
		buffer width	Type 4 and untyped perennial streams <5' wide			100' buffer of mature native vegetation on each side.
		buffer width	Type 5 and all other untyped streams			50' buffer of mature native vegetation on each side
	PHS	buffer width	Type 1&2 or Shorelines of Statewide Significance			250'
		buffer width	Type 3 or other streams 5-20' wide			200'
		buffer width	Type 3 or other streams <5' wide			150'
			Other intermittent streams with low mass wasting potential			150'

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good																																				
		buffer width	Other intermittent streams with high mass wasting potential			225'																																				
	WSA	Species, average tree size, and density within 100' of channel	All channels <20% gradient	HSS, HSD, MSS, MSD, CSS, CSD, HMS, HLS	HMD, MMS, CMS, CLS, HLD, MLS	CMD, MMD, MLD, CLD																																				
				<table border="1"> <thead> <tr> <th>Column</th> <th>Code</th> <th>Class</th> <th>Species</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>C</td> <td>Conifer</td> <td>? 70% conifer</td> </tr> <tr> <td></td> <td>H</td> <td>Hardwood</td> <td>? 70% hardwood</td> </tr> <tr> <td></td> <td>M</td> <td>Mixed</td> <td>all other cases (mixed)</td> </tr> <tr> <td>2</td> <td>S</td> <td>Small</td> <td><u>Average tree size</u> &lt;12 inches dbh</td> </tr> <tr> <td></td> <td>M</td> <td>Medium</td> <td>12-20 inches dbh</td> </tr> <tr> <td></td> <td>L</td> <td>Large</td> <td>? 20" dbh</td> </tr> <tr> <td>3</td> <td>S</td> <td>Sparse</td> <td><u>Ground exposed</u> &gt;33% (Western WA) &gt;50% (Eastern WA)</td> </tr> <tr> <td></td> <td>D</td> <td>Dense</td> <td>? 33% (Western WA) ? 50% (Eastern WA)</td> </tr> </tbody> </table>	Column	Code	Class	Species	1	C	Conifer	? 70% conifer		H	Hardwood	? 70% hardwood		M	Mixed	all other cases (mixed)	2	S	Small	<u>Average tree size</u> <12 inches dbh		M	Medium	12-20 inches dbh		L	Large	? 20" dbh	3	S	Sparse	<u>Ground exposed</u> >33% (Western WA) >50% (Eastern WA)		D	Dense	? 33% (Western WA) ? 50% (Eastern WA)		
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	NMFS			?	?	?																																				
	Skagit	buffer width	All	<20 m	20-40 m	? 40 m																																				

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
	Hood Canal	vegetation composition	(summer chum)	Deciduous dominated (>70% of the canopy)	Mixed	Conifer dominated (<70% of the canopy)
		average stand diameter	(summer chum)	< 12 inches dbh	12-20 inches dbh	>20 inches dbh
		stand density	(summer chum)	>80% ground exposure	33-80% ground exposure	<33% ground exposure
		extent	(summer chum)	<66' wide forested buffer	66-132' wide forested buffer	>132' wide forested buffer
		buffer width	annual streams			250' buffer measured horizontally from channel migration zone or 100-yr floodplain (whichever is greater)
		buffer width	seasonal streams			Site potential tree height measured horizontally from ordinary high water mark
<b>Streambank Stability</b>	WSP	% of banks not actively eroding	all			>90% stable

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
	WSA					
	NMFS	% of banks not actively eroding	all	<80% stable	80-90% stable	>90% stable
	Hood Canal					
	Skagit					

**Table D2: Review of salmonid habitat condition ratings**

Habitat Factor	Source	Parameter/Unit	Channel Type	Poor	Fair	Good
<b>Floodplain</b>	WSP					
	WSA					
	NMFS		All	severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly	reduced linkage of wetland, floodplains, and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession
	Skagit	(in development)		?	?	?
	Hood Canal					

The following criteria in Table D3 were selected by the Wenatchee TAC as acceptable for rating habitat elements on a reach and/or watershed level in the Wenatchee basin (WRIA 45). These criteria are to be applied based on reviews of existing data sources, or, alternatively from the combined professional expertise of the TAC where data was unavailable or where analysis of data had not been conducted. It is assumed that both the interpretation of existing data sources and the application of professional knowledge to watershed ratings required best professional judgement. When using these criteria in the assessment process, the rating clarifies whether quantitative studies or published reports, or qualitative, professional knowledge was used for rating the habitat factors.

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

<b>Habitat Factor</b>	<b>Parameter/Unit</b>	<b>Channel Type</b>	<b>Poor  (Not Properly Functioning)</b>	<b>Fair  (At Risk)</b>	<b>Good  (Properly Functioning)</b>	<b>Source</b>
<b>Access to Spawning and Rearing Habitat</b>						
Artificial Obstruction	Man-made physical barriers (address subsurface flows or dewatering where they impede fish passage under water quality attributes)	All	Man-made barriers present in reaches do not allow upstream and /or downstream fish passage at a range of flows.	Man-made barriers present in the reach do not allow ustream and/or downstream fish passage at base/low flows.	Man-made barriers present in the reach allow upstream and downstream fish passage at all flows.	USFWS Guidelines
Screens and Water Diversion Ditches	Water diversions structures, both gravity and pump	All	Does not meet NMFS juvenile fish screens criteria.	Meets all NMFS criteria for juvenile fish screens except screen mesh size.	Meets NMFS juvenile fish screen criteria.	NMFS Juvenile Fish Screen Criteria and Addendum for Pump Intakes

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
<b>Riparian Condition</b>						
Riparian Condition	Riparian corridors, wetlands, intermittent headwater streams, and other areas where proper ecological functioning is crucial to maintenance of the stream's water, sediment, woody debris and nutrient delivery systems (definition taken from PACFISH for 'riparian habitat conservation areas – see glossary)	All – Eastside	riparian areas are fragmented, poorly connected, or provide inadequate protection of habitats for sensitive aquatic species (<70% intact, refugia does not occur), and adequately buffer impacts on rangelands; percent similarity of riparian vegetation to the potential natural community/composition is <25%.	moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian areas, or incomplete protection of habitats and refugia for sensitive aquatic species (? 70-80% intact) and adequately buffers impacts on rangelands: percent similarity of riparian vegetation to the potential natural community/composition is 25-50% or better.	the riparian areas provide adequate shade, LWD recruitment, and habitat protection and connectivity in subwatersheds, and buffers or includes known refugia for sensitive aquatic species (>80% intact) and adequately buffers impacts on rangelands: percent similarity of riparian vegetation to the potential natural community/composition is >50%.	USFWS Guidelines

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

<b>Habitat Factor</b>	<b>Parameter/Unit</b>	<b>Channel Type</b>	<b>Poor (Not Properly Functioning)</b>	<b>Fair (At Risk)</b>	<b>Good (Properly Functioning)</b>	<b>Source</b>
<b>Channel Conditions/Dynamics</b>						
Streambank Condition	% of stream reach in stable condition	All -Eastside	<50% of any stream reach has ?90% stability	50–80% of any stream reach has ?90% stability	>80% of any stream reach has ?90% stability	USFWS Guidelines
Floodplain Connectivity	Stream and off-channel habitat length with lost floodplain connectivity due to incision, roads, dikes, flood protection, or other	All - Eastside	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetlands extent drastically reduced and riparian vegetation/succession altered significantly.	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function and riparian vegetation/succession.	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession.	USFWS Guidelines
Width/Depth Ratio	Bankfull width/ average depth of bankfull channel	All	>12  (high width/depth ratio; shallow channel)	>10 - 12  (moderate width/depth ratio)	<10  (low width/depth ratio; deep channel)	Rosgen

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

<b>Habitat Factor</b>	<b>Parameter/Unit</b>	<b>Channel Type</b>	<b>Poor (Not Properly Functioning)</b>	<b>Fair (At Risk)</b>	<b>Good (Properly Functioning)</b>	<b>Source</b>
Entrenchment Ratio	Flood-prone width/ bankfull channel width (flood-prone width = water level @ 2x max depth	All	<1.4  (entrenched)	1.4 – 2.2  (moderately entrenched)	>2.2  (slightly entrenched)	Rosgen

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
<b>Habitat Elements</b>						
Channel Substrate	Substrate condition as it related to rearing habitat, including but non limited to, the degree of substrate embeddedness and substrate mobility.	All – Eastside	>30% embeddedness	20 – 30% embeddedness	<20% embeddedness	USFWS Guidelines
Large Woody Debris	Pieces/mile that are >12” in diameter and >35 ft. in length; also adequate sources of woody debris are available for both long and short-term recruitment	All – Eastside	Current levels are not at those desired values for “Good/Properly Functioning”, and potential sources of woody debris for short and /or long term recruitment are lacking	Current values are being maintained at minimum levels desired for “Good/Functioning Appropriately”, but potential sources for long-term woody debris recruitment are lacking to maintain these minimum values	Current values are being maintained at greater than >20 pieces/mile, >12” in diameter and >35” ft. in length.	USFWS Guidelines

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
Habitat Elements (continued)						
Pool Frequency	% wetted channel surface area comprising pools	All	Pool frequency is considerably lower than values desired for “good/properly functioning”.	Pool frequency is similar to values in “good/properly functioning”.	Pool frequency in a reach closely approximates: Wetted # Pools/ Width mile (ft) 0–5 39 60 48 39 23 18 10 9 4 (can use formula: pools/ mile = 5,280/ wetted channel width ? # channel widths per pool	USFWS Guidelines
Pool Depth	Pools >1 meter deep	Streams >3m in wetted width	No pools	few pools	many pools present	USFWS Guidelines

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
<b>Habitat Elements (continued)</b>						
Off-channel Habitat	Area within the channel migration zone.	Reaches with average gradient <2%	Reach has few or no ponds, oxbows, backwaters, or other off-channel areas	Reach has some ponds, oxbows, backwaters, and other off-channel areas with cover; but side-channel areas are generally high energy areas	Reach has many ponds, oxbows, backwaters, and other off-channel areas with cover; and side-channels are low energy areas	USFWS Guidelines

**Table D3:Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

Habitat Factor	Parameter/Unit	Channel Type	Poor (Not Properly Functioning)	Fair (At Risk)	Good (Properly Functioning)	Source
<b>Water Quality</b>						
Temperature	degrees Celsius/ degrees Fahrenheit	All	<p>&gt;15.6? C/ 60?F (spawning) or</p> <p>&gt;17.8? C/ 64?F (migration and rearing) or</p> <p>For bull trout, 7- day average maximum temperature in a reach during the following life history stages:</p> <p>? &gt;15?C/ 59?F (rearing)</p> <p>? &lt;4?C or &gt; 10?C/ &lt;39?F or &gt;50?F (spawning)</p> <p>? &lt;1?C or &gt;6?C/</p>	<p>14-15.6?C/57-60 ?F (spawning) or</p> <p>14-17.8? C/57?- 64?F (migration and rearing) or</p> <p>For bull trout, 7-day average maximum temperature in a reach during the following life history stages:</p> <p>? &lt;4?C or &gt;13-15°C/ &lt;39?F or &gt;55°-59°F (rearing)</p> <p>? &lt;4?C or &gt;10?C/ &lt;39?F or 50?F (spawning)</p> <p>? &lt;2?C or &gt;6?C/</p>	<p>10-14?C/50?-57?F or</p> <p>For bull trout, 7- day average maximum temperature in a reach during the following life history stages:</p> <p>? 4?-12°C/ 39?- 54°F (rearing)</p> <p>? 4? - 9°C/ 39?-48 ?F (spawning)</p> <p>? 2?-5?C/ 36?-41°F (incubation)</p>	NMFS and USFWS Guidelines

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

Habitat Factor	Parameter/Unit	Channel Type	<b>Poor</b> <b>(Not Properly Functioning)</b>	<b>Fair</b> <b>(At Risk)</b>	<b>Good</b> <b>(Properly Functioning)</b>	Source
			34°F or 43°F (incubation)  also temperatures in areas used by adults during migration regularly exceed 15°C (59°F) (thermal barriers present)	36°F or 43°F (incubation)  also temperatures in areas used by adults during migration sometimes exceed 15°C (59°F)	also temperatures do not exceed 15°C (59°F) in areas used by adults during migration (no thermal barriers)	

**Table D3: Wenatchee Watershed 2496 TAC Salmonid Habitat Rating Criteria**

<b>Habitat Factor</b>	<b>Parameter/Unit</b>	<b>Channel Type</b>	<b>Poor (Not Properly Functioning)</b>	<b>Fair (At Risk)</b>	<b>Good (Properly Functioning)</b>	<b>Source</b>
<b>Water Quality (continued)</b>						
Fine Sediment	finer <0.85mm in areas of spawning and incubation	All – Eastside	>17%	12 – 17	<12%	USFWS Guidelines
<b>Water Quantity</b>						
Dewatering	presence/absence in a stream reach	All	No flows during some portion of the year	Not applicable	Flows present year-round	TAC
Change in Flow Regime	Change in Peak/Base Flows	All	pronounced changes in peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	some evidence of altered peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology and geography	USFWS Guidelines